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ROBOT CAR SMACKDOWN

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← ACTUAL SIZE Invasion of the Sub-Sub-Subcompact

POPULAR SCIENCE

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ISSUE



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4 Drivable Pods



→ The All-Electric
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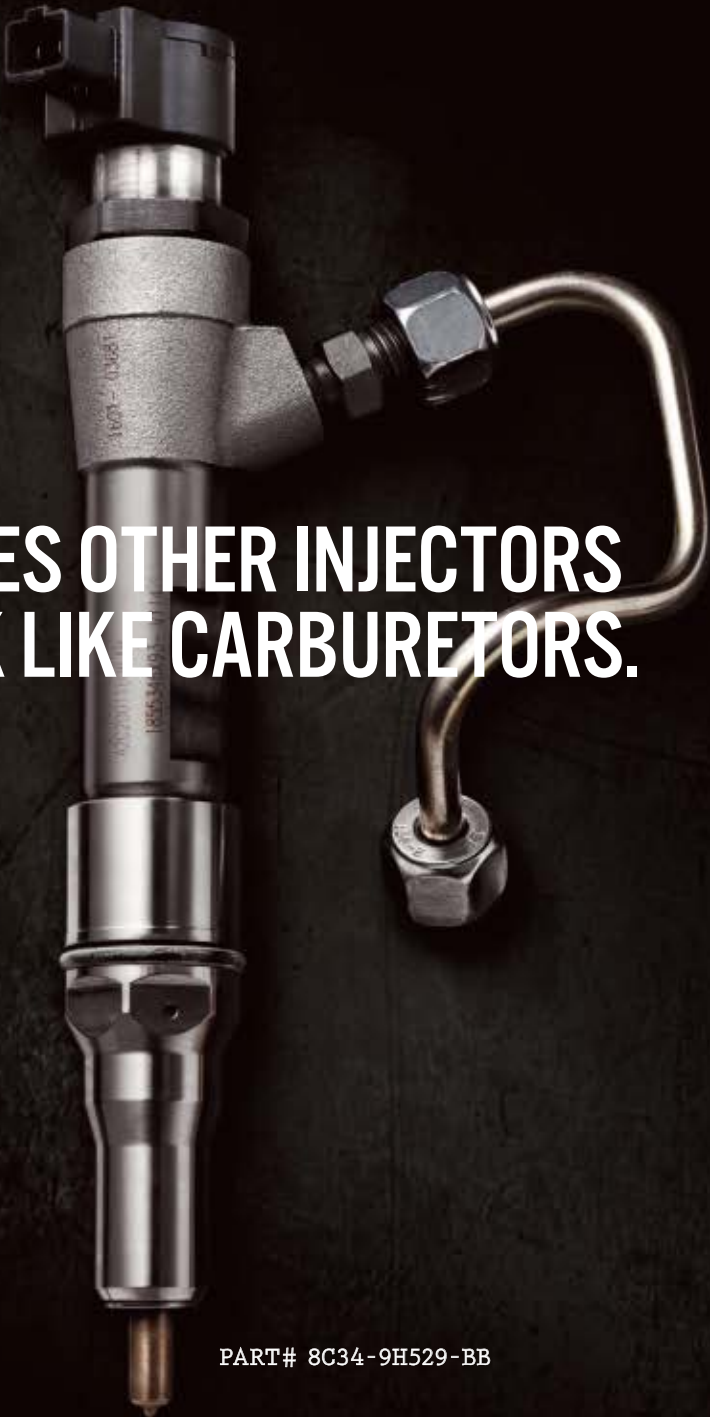
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A large suspension bridge, likely the Manhattan Bridge, spans a body of water. The scene is captured at sunset or sunrise, with a warm, golden light illuminating the sky and the water's surface. The bridge's steel structure, including its massive towers and numerous suspension cables, is silhouetted against the bright sky. In the background, the city skyline is visible, with several tall buildings and industrial structures. The water in the foreground shows gentle ripples and a small wake from a boat. A metal railing is visible in the bottom left corner.

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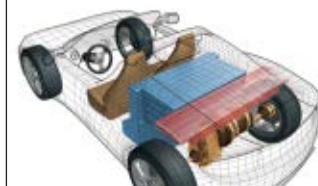
W W W . P O P S C I . C O M



CAR-TOONS See animated 3-D models of PopSci's concept cars when you visit our online gallery.

CARS 2.0: VROOMIER!

Can't get enough of the futuristic vehicles in this issue? Visit popsci.com/futurecars for exclusive videos and animations that put you behind the wheel of tomorrow's coolest rides.



POPSCI PODCASTS

BROADCAST NEWS

Listen in every week as our moon-based troubadour, Jonathan Coulton, delivers his award-winning PopSci podcast. Last month Coulton talked about turning trash into fuel, NASA's latest emergency plans and the newest addictive videogame by *Sims* designer Will Wright. He also took second place in the podcast category at the Magazine Publishers of America Digital Awards and made iTunes's Top Ten Podcasts of 2006. Hear what this month brings at popsci.com/podcast.

MORE
WEB
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► IF YOU BUILD IT, WE WILL BLOG

We're rolling out even more hot hacks and mad mods on our new How 2.0 blog. Look for weekly projects from our resident DIY guy, Dave Prochnow, and submit your own ideas at popsci.com/h20blog.



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Power, Performance, Virtue



THE LAST TIME WE PUBLISHED a "Future of the Car" special issue, in September 2004, we celebrated a new golden age of driving fostered by the convergence of power, performance and cheap gas. My, how times have changed in three years, with pump inflation and global-warming alarms conspiring to make some of our earlier hosannas sound almost quaint.

Today vehicular virtue has transcended its red-carpet badge-of-honor status to become a statement with more of an everyman appeal. When Ford recently unveiled a prototype electric/fuel-cell version of its Edge crossover vehicle, much was made of the two splashy fueling-port sockets on either side of the driver's-

"Vehicular virtue has transcended its red-carpet status to become a statement with everyman appeal."

side door. "I told the design team to make them prominent," said Ford's manager of fuel-cell-vehicle engineering, Mujeeb I. Ijaz. Clearly, it's chic to be green. More tellingly, when writer McKenzie Funk rented a squat Smart microcar for a road trip down Route 66 [page 82], he found that a notable proportion of the gawkers he attracted asked longingly about the mileage he was getting.

But this is America, and let's face it: The only way we're going to see a true mass embrace of environmentally friendly, energy-efficient automobiles is if they don't require us to sacrifice on the twin pillars of our car passion: power and performance. Which is why I am so heartened by the story of JB Straubel [page 68], the 31-year-old chief technical officer at Tesla Motors, who bucked auto-industry conventional wisdom by assembling a grid of some 7,000 lithium-ion laptop batteries to power his all-electric Tesla Roadster, which has a range of 250 miles and will rocket past a Lamborghini off the line, 0-60 in four seconds. The first models will go on sale this summer. At \$100,000 apiece and with an effective battery life of about five years, it doesn't exactly overcome every hurdle to delivering power, performance and virtue in a single package. But it gives us a glimpse at the no-compromise glories that will be possible in the very near future.

Welcome to the *new* golden age of driving.

MARK JANNOT

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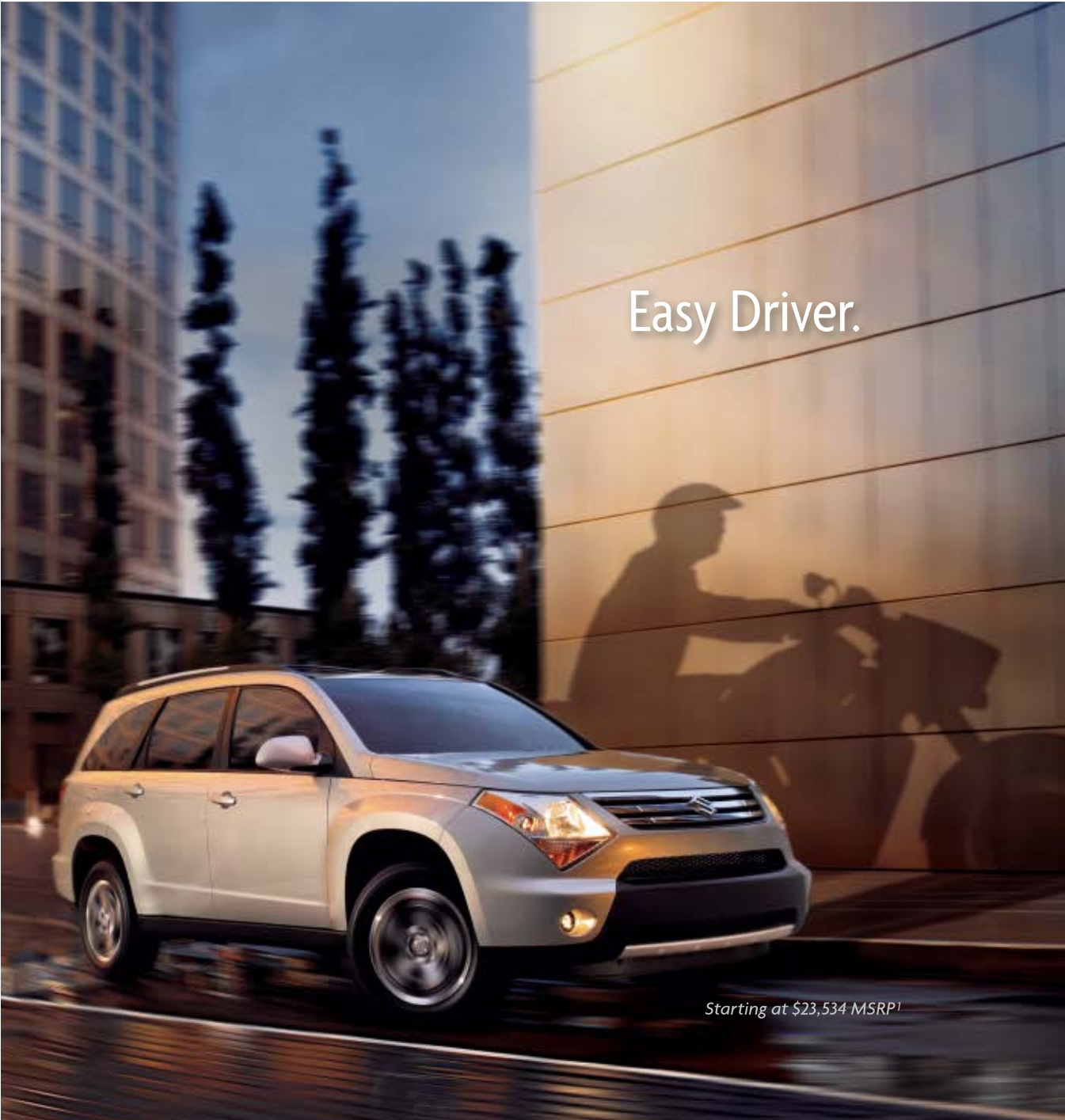
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LETTERS

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Booming Business

"Rattling dishes" are annoying ["All Sonic, No Boom," Concepts & Prototypes, March], but that isn't why supersonic overflights were banned. I worked on sonic-boom research for the FAA in the 1970s. Our studies showed that the pressure wave, not the noise, was what startled most people. About 20 percent never adapted to it. The FAA concluded that we couldn't have 20 percent of surgeons, drivers and others jumping out of their skin whenever a supersonic craft flew over. I hope the spreading out of the pressure wave solves the problem; otherwise, the venture will again fail.

J.P. Bailey
Lawton, Okla.

Safety Light

In "Hide Your Wi-Fi Away" [How 2.0, March], you explain how to hide a homemade Wi-Fi antenna system inside a light fixture. When looking at the illustrations, I see safety concerns with the hot lightbulbs. Wouldn't this project violate various safety codes?

Matthew C. Jackson
Troy, Mich.

Senior editor Mike Haney replies: Mr. Jackson raises a good point that we can't emphasize enough: Any project that involves modifying an existing product carries some risk, so researching applicable regulations and following safety precautions is a must. Always call a professional if you're not sure.

Regarding the bulb, author Dave Prochnow's original draft for this project called for a homemade LED bulb to avoid the concern over excess heat. For the photo shoot, we used a small, cool (10-watt) incandescent because of its more recognizable shape, and we left the cover off the fixture, which would further help cool the unit. Another reader offered an alternative solution: Have an electrician install an outlet in a hallway wall, up high, and mount the Wi-Fi antenna beside it. If you don't like the cool tech look in the hallway, build an inexpensive smoked Plexiglas cover to hang over the unit.

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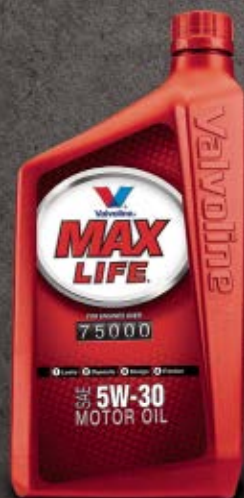


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MEGAPIXELS

THE MUST-SEE PHOTOS OF THE MONTH



COURTESY MARINE ADVANCED RESEARCH

WATER BUGGY

A prototype watercraft is designed to go almost anywhere, bump-free

It's known as *Proteus*, and its performance is just as unusual as its appearance. The creation of California company Marine Advanced Research, this leggy craft is the helicopter of boats, explains designer Ugo Conti, who says *Proteus* clones could someday be used for quickly deploying research equipment to far-flung locales or for ocean search-and-rescue operations. The range of conventional craft is limited by their ability to take the pounding of huge swells in the open ocean and by the depth of the boats' draft in shallow water. *Proteus*'s catamaran-style hulls displace only 18 inches, so it can operate safely close to shore. And the vehicle is designed to surf on top of the waves, rather than cut through them, allowing it to travel safely and efficiently in rough seas. The ride can't be beat: The cockpit is suspended on four aluminum legs attached to the hulls by titanium springs. Which means no bumps—and a view 12 feet above the waves. **BY MARK SCHROPE**
PHOTOGRAPH BY TOBY THIERMANN



PONTOON POWER *Proteus* motors around San Francisco Bay.





A large number of bluebottle jellyfish are washed onto a sandy beach. The jellyfish are a deep purple-blue color with a lighter, ribbed pattern on their bell. They are scattered across the sand, some lying flat and others slightly inflated. The background shows a wide expanse of beach leading to the ocean under a clear sky.

BLUE CRUSH

In Australia, bluebottle jellyfish invade in striking numbers

Sailing ashore on blustery northeast winds, vast armadas of half-foot-long bluebottle jellyfish took Australia's Gold Coast beaches by storm this year. The smaller, electric-blue cousin of the Portuguese man-o'-war (both species are technically polyps) commonly blows in to southern beaches during the summer months—November to February, Down Under—in dense packs. (This flotilla was photographed on Terrigal Beach in New South Wales.) But seldom have they arrived in such nettlesome droves: In a single January weekend, Queensland lifeguards treated 600 stings, a stunning increase over the 476 stings recorded for that entire month in 2006 (though painful, stings are almost never deadly). It's unclear whether there has been a population spike among the sail-shaped, gelatinous invertebrates or if the wind patterns are simply bringing more of them ashore, says Lisa-Ann Gershwin, a jellyfish expert at James Cook University in Queensland. "They live way out in the central gyres in the middle of the great oceans," she explains, "but so far nobody's bothered to go out there and count them." BY TOM COLLIGAN PHOTOGRAPH BY BELINDA CURLEY



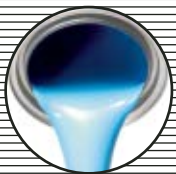
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A pocket printer that uses no ink



24

Little cameras with huge zooms



26

The latest fashion—downloaded

A SMARTER PHONE

The first fully programmable phone does what you—not Apple or Verizon—want it to do

A CURVACEOUS DO-IT-ALL cellphone with a giant touchscreen: No, it's not the much-hyped iPhone. It's the open-source Neo1973.

No matter what phone you're carrying now, its manufacturer and your wireless provider control what applications are allowed to do with the phone's hardware (its microphone, speaker and screen), ensuring consistent, albeit bland, performance. With the Neo1973, any amateur hacker can write an application—or tweak the OpenMoko Linux operating system—to make the handheld do anything. And average users can download these whiz-bang new apps through a simple interface.

What could the programs do? Imagine if the phone's mic could tell that you're having an in-person conversation and hold all calls. Or if the built-in GPS chip determined your location and set your ringtone profile: silent for the movies, loud for the street.

The Neo1973 will be sold only at openmoko.org, but you can get service for it by slipping in a SIM card from AT&T or T-Mobile. Rough "developer" models are available now; polished "end-user" versions will come calling in September.—JOHN MAHONEY

FIC NE01973

COMMUNICATION: Quad-band GSM/GPRS, Bluetooth 2.0, USB

WORKS WITH: AT&T, T-Mobile

DISPLAY: 2.8-inch VGA touchscreen

DIMENSIONS: 4.8 x 2.4 x 0.7 inches

GET IT: \$350; openmoko.org

► **HOME RUN**
Customize the Neo's home screen with oft-used programs, or "widgets."



SATOSHI

WHAT'S NEW

SHINE ON

Car wax takes too long to apply and wears off too soon. But this silicone-based cream instantly bonds to the clear-coat finish found on most autos, and the protection lasts three times as long as usual—for at least 10 washes.

3M Performance Finish
\$15; 3m.com



REFURBISHED FLOOR MODEL

Many rugs, it turns out, use a nylon that can be melted and respun indefinitely. Shaw saves such rugs from the landfill to create the first new carpet made from old scraps.

Shaw Anso Nylon From
\$4.50/sq. ft.; shawfloors.com



EXIT STRATEGY

Never miss your exit on the freeway again. This GPS navigation device illustrates major highways right down to the individual lanes. Arrows show you when to switch lanes in order to nail your turn, a first among handheld GPS units.

Fujitsu Siemens Pocket LOOX N100 \$500; navigon.com



GOOD LISTENER Three microphone capsules inside this palm-sized recorder pick up full surround sound, perfect for saving impromptu jam sessions or creating like-you-were-there podcasts. **Zoom H2 Handy Recorder** \$200; samsontech.com

SAW III

This attachment turns RotoZip's drill-like hole cutter into a flush-cut saw (which cuts parallel to the ground for tasks like trimming floor molding) or a small circular saw. Slip in a heat-diffusing, diamond-coated serrated blade, and it becomes a tile cutter that doesn't require water-cooling.

XShield \$40; rotozip.com



PORT SECURITY

The longer you're online, the more time hackers have to invade. This smart plug tracks your monitor's power usage. When the screen goes to sleep, it closes the network connection.

DataBreaker
\$40; databreaker.com



SOFT ROCK

To maintain steady footing on bumpy paths, these trail runners turn the usual sport shoe inside out: The inner lining provides the firmest support, while the cushiony foam sole wraps around rocks, keeping your foot level. **GoLite Sun**

Dragon \$95; www.golite-footwear.com



BLUES TRAVELER

Pack this water-proof, dent-proof guitar in your carry-on—it's less than two thirds the normal size and weighs about three pounds. The hollow carbon-fiber neck allows it to resonate much like a larger guitar.

Blackbird
Rider \$1,600; blackbirdguitar.com



GLISTEN TO THE MUSIC

Foam earphones fit snugly, but—ew—they attract ear gunk. Shure made the covers of these high-end buds washable by flowing foam into a mold that forms a nonporous finish on the outside. **Shure SE530 \$450; shure.com**



THE GOODS

12 MUST-HAVE PRODUCTS
BY LAUREN AARONSON

JUST-RIGHT LIGHT

The first dimmable LED flashlight can be a bright task lamp—or a battery-saving faint glow that won't wake your bunkmate. Turn the bezel of its three-inch titanium tube, and a resistor adjusts brightness from 0 to 70 lumens. **SureFire Titan \$500; surefire.com**



LONG-DISTANCE SERVICE

Forgot an e-mail on your PC? Grab it from afar by logging in to this home server, the first consumer model to open files and programs on networked computers. **HP MediaSmart Server Price not set; hp.com**



CALL YOUR SHOTS

Don't wait until you get home to offload photos from this camera. With its high-speed HSDPA cellular module, it wirelessly transfers data wherever you get a cell signal. **Samsung VLUU i70 Price not available; samsung.com**

IT'S ABOUT TIME THE FAST, NO-STINK SUPER PAINT

Avoid backache with an eco-friendly paint that covers in one coat and dries before sundown

PAINTING WILL NO LONGER be a smelly, time-consuming chore. With Benjamin Moore & Co.'s new Aura interior-paint line, you can start without the primer and finish without the lingering odor, all in a single afternoon. The secret: a new "co-polymer surfactant" molecule that binds the color into a thicker, more durable paint.

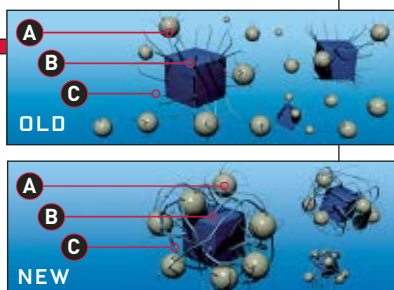
Latex paints use chemicals called surfactants that help glue color pigments to the tiny latex beads. Trouble is, traditional surfactants create weak bonds that result in a thin, porous paint film. To solve this problem, Benjamin Moore engineered a technology called ColorLock. It uses a surfactant made of long polymer chains to envelop the pigment molecules—imagine a strip of Velcro wrapped around a tennis ball—providing

more space to which the latex spheres can cling. The result is a paint that covers any color in a single coat, leaves a washable finish, and dries in hours instead of a day. So although a gallon costs \$55, you'll need only half as much. And the new chemistry virtually eliminates volatile organic compounds (VOCs), the nasty chemicals that make paint stink and contribute to smog.

Aura debuted in January in California, where VOC regulations are strictest, and came to New York in March. But it could take another year to migrate elsewhere, as stores upgrade their tinting equipment for the new technology. That gives you the perfect excuse to put off painting the living room.—NICOLE DYER

HOW IT WORKS

LATEX PAINT consists of four basic ingredients. Tiny beads of latex **[A]** hold the paint mixture together after it dries, pigment **[B]** provides color, surfactant **[C]** binds the latex to the pigment, and water thins the mixture for application. Aura uses a new type of surfactant in long polymer chains that wrap tightly around the pigment particles, creating more surface area to which latex beads can attach.



IN RELATED NEWS: A STRONG ACCENT

Can't get your hands on Aura? Try Sherwin-Williams's new line of bright accent paints called Duration Home, which hits shelves nationwide this month in more than 300 colors. Like Aura, Duration Home is a low-VOC paint with a stain-resistant finish that won't rub off or get a shiny look when you wash it. The company credits the performance to "cross-linking" latex particles that bind tightly to pigments and keep the paint firmly glued to the wall's surface. Unlike with Aura, however, you'll still need primer and a second coat. **\$43/gallon; sherwin-williams.com**

◀ **SMOOTH POUR** Aura rolls and brushes on evenly, thanks to its novel chemistry.



COLORS: 3,300
COST: \$55/gallon
GET IT: benjaminmoore.com

SAY NO TO NO

Isn't it high time someone got negative about negativity?
Yes it is.

Look around. The world is full of things that, according to nay-sayers, should never have happened.

"Impossible."

"Impractical."

"No."

And yet "yes."

Yes, continents have been found.

Yes, men have played golf on the moon.

Yes, straw is being turned into biofuel to power cars.

Yes, yes, yes.

What does it take to turn no into yes?

Curiosity. An open mind. A willingness to take risks.

And, when the problem seems most insoluble, when the challenge is hardest, when everyone else is shaking their heads, to say: let's go.

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HOW
IT WORKSTHE INKLESS
PRINTER

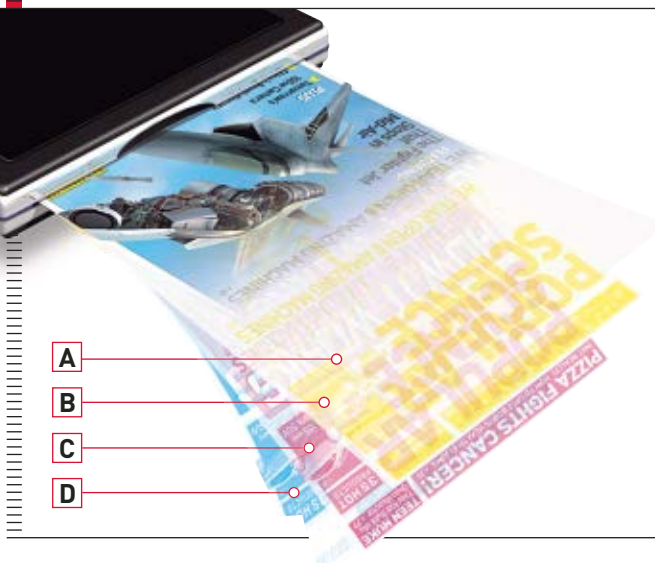
Using a new kind of paper and dye, this device fits in your pocket—or even a camera—and makes photos appear like magic

TO MAKE A PRINTER as small as today's palm-sized cameras, engineers removed the one ingredient that seems essential: the ink. Polaroid spin-off Zink instead layers dyes that initially look clear onto sheets of plastic "paper." When blasted by hundreds of small heaters in the print head, the dyes change color, producing a water-resistant image that lasts about 10 years. Zink expects two products that use its technology to debut later this year: a \$100, wallet-size, Bluetooth-enabled printer [shown here] to go with a cellphone and a \$200 camera with a built-in printer. Fill either with a 10-pack of paper for about \$2.—LAUREN AARONSON

HANDY PRINTER The Zink produces 20 2x3-inch images per charge.



HOW TO PRINT WITHOUT INK



The Zink printer spits out a 2-by-3-inch photo—using some 200 million heat pulses—in only 30 seconds. Beneath its clear finish **[A]**, the paper contains a layer of dye a few microns thick for each of three colors. Individual dyes begin in transparent, crystalline form. When heated, the molecules melt into a random arrangement that causes the dye to absorb light and take on color.

To activate the dye, the sheets pass under a print head with 600 small ceramic heating elements—one for each pixel—

that create the photo one row at a time. To turn a pixel yellow, high heat (hundreds of degrees) blasts for a short time (about a tenth of a microsecond). The heat triggers the yellow dye **[B]** but not the magenta and cyan layers. A longer blast of medium heat—too cool to affect the yellow dye—melts the magenta layer **[C]**. Activating the cyan layer **[D]** requires a longer blast of lower heat. The printer blends colors by pulsing several times in quick succession to melt each layer just enough to get the necessary shade.



Protect your engine from pressure.

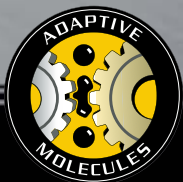
Your engine's internal combustion creates horsepower. Sadly, it also creates one of your engine's greatest enemies – pressure. Over time, pressure can damage your motor oil, decreasing its ability to deliver full protection. Fortunately, Pennzoil Platinum™ Full Synthetic motor oil is formulated to stand up to that pressure.

Pennzoil Platinum protects engines with adaptive molecules. When faced with intense pressure, adaptive molecules cluster together, creating a barrier to help absorb the impact like a cushion. When the pressure subsides, the adaptive molecules return to normal.

And pressure isn't the only enemy adaptive molecules resist. They also resist heat and shearing. When adaptive molecules encounter severe heat, they break apart to avoid harm, yet continue to provide excellent protection. And when adaptive molecules enter areas where they can be sheared apart, they split again, reforming as soon as they have slipped through.

Amazingly, adaptive molecules can go from separating to avoid permanent shear, to clumping together against pressure, right back to separating to evade heat, over and over. This helps Pennzoil Platinum maintain viscosity, which helps keep engines running stronger, longer. So help your engine fight the enemies within. Give it the adaptive molecules in Pennzoil Platinum motor oil.

Visit PennzoilPlatinum.com to learn more about adaptive molecules.



Not just oil, Pennzoil.



TECH
TREND

SMALL CAMERAS WITH BIG ZOOMS

Clever optics double and triple the close-up power of compact cameras



THE TREND

Affordable compact cameras are graduating beyond the standard 3x optical-zoom capability, gaining wide-angle and telephoto powers that rival \$1,000-plus, multi-lens SLR setups.

WHY NOW

Economies of scale are making sophisticated lens systems more affordable. Better digital processing and mechanical image stabilization help keep even super-zoomed photos looking crisp.

HOW YOU'LL BENEFIT

You can catch a close-up of your Little Leaguer from the stands, or get the whole baseball diamond in a single shot, without having to lug a bag full of camera gear.

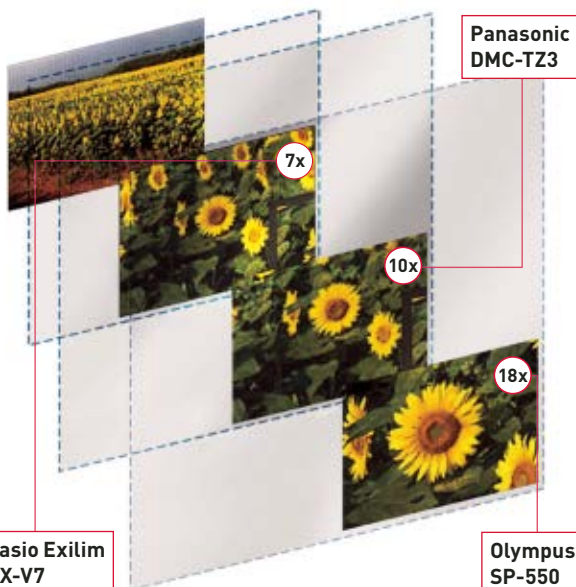
—SEÁN CAPTAIN

SAVING SPACE WITH ODD-SHAPED LENSES

Special glass gives Olympus the first 18x (28mm–504mm) zoom. Typical lenses either bulge outward or hollow inward, creating evenly curved surfaces like those of a sphere. But they distort shapes and colors at their edges, requiring correction by other lenses. This 7.1-megapixel

camera uses four aspheric lenses, which minimize distortions by curving less at the edge than at the center. And motors nudge the image sensor to counteract camera shake so that high zoom doesn't magnify little jitters into big blurs. **Olympus SP-550 \$500; olympusamerica.com**

LET THE LENS DO THE WORK



COME CLOSER A long zoom allows you to radically change the photographic perspective without having to move an inch.



USING OPTICAL AND DIGITAL TRICKS

This 1.47-inch-thick camera packs a 10x (28mm–280mm) zoom using two standard aspheric elements and one meniscus lens. Resembling a contact lens, a meniscus is concave (bulging outward) on one side and convex (bending inward) on the other, providing two aspheric surfaces in one lens. The image processor fixes any optical distortions, and another lens moves to counteract camera shake.

Panasonic Lumix DMC-TZ3 \$350; panasonic.com



BENDING LIGHT AROUND CORNERS

Most zooms telescope outward when the camera powers up, but this model stays only one inch thick by using a lens barrel that resembles a periscope. Light enters at the front of the camera, hits a prism, and bends 90 degrees to pass through additional lenses within the body. Other cameras have such "folded optics," yet this one achieves a record 7x (38mm–266mm) zoom.

Casio Exilim Hi-Zoom EX-V7 \$400; casio.com

See how easy it is to get started boating with your free DVD at DiscoverBoating.com.

Dogs need weekends, too.





THE TECH BEHIND THE CONCEPT

◀ DIAL-UP DESIGNS

Someday your cellphone (like this one covered in a new “wood paper” from sheerveneer.com) could be the control center for your customizable shoes, downloading and sending them new patterns.

▲ THE POWERLESS DISPLAY

The key to building a sneaker with a display that can change patterns anytime: Cut down its power needs to virtually nothing. These concept shoes use a type of screen, known as a cholesteric LCD, that needs no backlight and can hold an image for years—without power.

The molecules inside the display have two stable orientations. In one, they are twisted so that they reflect a particular wavelength of light, making an area of the screen appear, say, dark blue. But when a charge is applied to certain areas, the molecules untwist, letting light through to reveal the background color instead. Because the molecules maintain the same orientation until charged again, the design stays put.

Developed at Kent State University in the 1990s, the screens are now mostly used for store signage (they refresh too slowly for video). Researchers are working on making screens that can show several colors and on making them flexible enough to be sewn onto clothes. kentdisplays.com

CONCEPT

CUSTOM KICKS

A little-known display technology could someday let you change the look of your shoes (or other clothing) whenever the mood hit

THE CONCEPT: Ever walk into a party and see someone with the same shoes? Reclaim your unique style by pulling out your phone and beaming a new pattern to your feet. These sneakers, conceived by Inventables [see box, right], would incorporate a screen that can show a two-color design or message indefinitely and uses electricity only when it changes. You would download new patterns

with your phone and send them to the shoes over Bluetooth. A small, flexible battery in the shoe would power thousands of changes. Special-edition sneakers can sell for hundreds of dollars today, so Inventables envisions pattern sales easily covering the shoes' higher manufacturing cost. Although the sneaks are just a concept, the screen technology is real. Nike, are you listening?—MIKE HANEY

WHOSE IDEA IS THIS ANYWAY?

Inventables is a self-styled “inspiration firm” in Chicago that tracks down new and little-known materials and technologies—such as this wood paper and LCD—and designs conceptual products based on them. See more creations at inventables.com.

Take the internet to **new** places

The Nokia N800 Internet Tablet lets you stay connected to the Internet almost anywhere. Pick up Wi-Fi signals through a wireless network or even through your compatible Bluetooth cellphone to create a mobile Internet experience.

You can even go beyond browsing: Get up-to-the-minute news updates via RSS feeds, play music, enjoy your photos, watch videos, listen to Internet radio, and make live video calls with friends and colleagues.



With the Nokia N800's open source technology, you can create your own applications and share them with others. M. Kangas New York, NY, the winner of this month's Nokia N800 Challenge, sent us a killer app idea: "HotSpotter." It would find Wi-Fi hotspots within range and uses the N800's Internet radio feature to audibly tell you where a hotspot is located. His HotSpotter idea is just one of many submissions we received from the contest. For more information on the Nokia N800 hop over to www.popsoci.com/nokia.

Custom Application Idea: "HotSpotter"



The device is so smart it recognizes different inputs. Using adaptive technology, it understands whether you're using your finger or the stylus and automatically adjusts the size of the keyboard for the right fit. Experience it all on the impressive high resolution screen.



Listen to your favorite tracks. Take a crash course in Italian. Stream Internet radio through the stereo speakers or the headphone jack. Enjoy your favorite photos and videos. Your vast media collection is in your pocket.

COMING
SOON

IS YOUR TV RINGING?

Real, live television is coming to your cellphone.
We took an early look at how two competing technologies stack up

MOST MOBILE TELEVISION isn't real TV—just blurry streaming video or sharper, brief clips that take forever to download. But two rival technologies can beam full-length shows and breaking news to your phone. DVB-H, an adaptation of the European broadcast system, is in trials in New York. Qualcomm's MediaFLO, developed especially

for handhelds, recently launched in select markets on Verizon and by year's end will be offered on AT&T. Instead of using inefficient data networks that bog down as people log on, both broadcast crisp digital TV signals to new cellphones (or other mobile devices, like laptops) equipped with special tuners.—MARK SPOONAUER

TECH: DVB-H

PROVIDER: Modeo

AVAILABILITY:

Unknown
(in trials now)

TV CHANNELS: 6,
plus 8 audio

PRICE: \$15/mo. (est.)

TESTED ON: Modeo
Mobile TV Smartphone

BATTERY LIFE: About
three hours of TV

THE VERDICT:

Launching the player took about 13 seconds, and channel changes averaged a sluggish seven seconds. But our screening of *Fox & Friends* and *E! News Daily* looked very clear—we could even read the tiny news ticker. Playback was generally smooth, with occasional stuttering and blockiness. Modeo hasn't yet signed up a cellphone carrier, but it is testing service on a prototype phone made by HTC.

CHANNELS: CNBC, Discovery Channel, E!, Fox News, Fox Sports, MSNBC, plus eight audio channels



TECH: MEDIAFLO

PROVIDER: Verizon Wireless

V CAST TV

AVAILABILITY: Now

TV CHANNELS: 8

PRICE: \$15/mo.

TESTED ON: LG VX9400

BATTERY LIFE: About three
hours of TV

THE VERDICT: An episode of *The Daily Show* looked stellar, with crisp, fluid video. And audio was in sync, unlike with current video offerings such as Sprint TV. Playback started in about five seconds, and channel changes took a brisk three seconds or less. Verizon offers live news and sports on special mobile versions of major networks, and it will play popular prime-time programs in the daytime. So, for example, *The Daily Show* might air during your lunch break. You can view schedules in advance on a cable-TV-like program guide, but sadly, you can't record content.

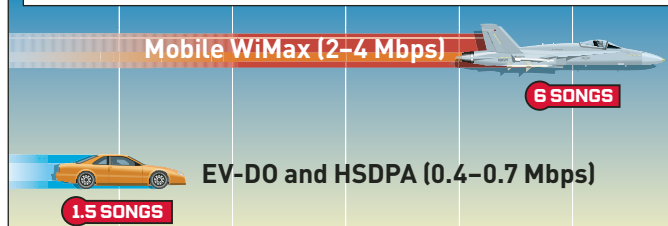
CHANNELS: CBS, Comedy Central, ESPN, Fox, MTV, NBC Entertainment, NBC News, Nickelodeon

WHAT'S
NEXT

WARP-SPEED WIRELESS

Today's "high-speed" wireless Internet technologies, EV-DO (from Sprint and Verizon) and HSDPA (from AT&T), provide piddling download rates of 0.4 to 0.7 megabit per second. But the new Mobile WiMax technology will hit 2 to 4 Mbps—enough to carry data and smooth Web video at once. Sprint will start testing Mobile WiMax later this year (charging \$55 per month) and will offer the service to some 100 million customers next year.

DOWNLOADS PER MINUTE



Want to spend more time having fun, and less time looking for a bathroom?

FLOMAX may improve male urinary symptoms due to BPH in **1 WEEK**.



Talk to your doctor. For many men, FLOMAX may help in one week.

FLOMAX is approved to treat male urinary symptoms due to BPH, also called enlarged prostate. Only your doctor can tell if your symptoms are due to BPH and not another condition such as prostate cancer. Common side effects are runny nose, dizziness and decrease in semen.

A sudden decrease in blood pressure may occur upon standing, rarely resulting in fainting. So avoid situations where injury could result. If considering cataract surgery, tell your eye surgeon you've taken FLOMAX. **To learn more, call 866-432-9734 or visit 4FLOMAX.com.**

If you can't afford FLOMAX, our Patient Assistance Program may help. Call 800-556-8317.

FLOMAX[®]
TAMSULOSIN HCl CAPSULES 0.4 MG

The 1-week difference.

Please see Patient Information on adjacent page.

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FLOMAX[®]

TAMSULOSIN HCl CAPSULES 0.4 MG

IMPORTANT PATIENT INFORMATION

What is FLOMAX?

FLOMAX is a prescription medication that is specifically designed to help relieve the signs and symptoms of *benign prostatic hyperplasia (BPH)*, a condition your physician may refer to as an enlarged prostate. FLOMAX works by relaxing the prostate muscles around the urethra, allowing urine to flow more freely out of the bladder. FLOMAX is NOT indicated for the treatment of high blood pressure.

Who should not use FLOMAX?

You should not take FLOMAX if you are allergic to tamsulosin hydrochloride or any other component of FLOMAX.

What should I be aware of before taking FLOMAX?

- o An enlarged prostate (BPH) and cancer of the prostate cause many of the same symptoms. It is important that you see your doctor first to rule out prostate cancer.
- o Though extremely rare, FLOMAX and other drugs in this class (alpha-1 blockers) have been associated with prolonged painful erection (priapism), which is unrelieved by sex. If this occurs, seek immediate medical attention, since this condition can lead to permanent inability to have an erection, if left untreated.
- o During cataract surgery, a condition known as intraoperative floppy iris syndrome (IFIS) has been observed in patients treated with drugs in this class. When considering cataract surgery, inform your surgeon if you are taking or have taken FLOMAX and/or other drugs in this class.
- o If you have had a serious reaction to sulfa, be sure to tell your doctor before taking FLOMAX.
- o FLOMAX should NOT be used in combination with other drugs in its class since interactions may be expected.
- o FLOMAX should be used with caution in combination with cimetidine or with warfarin (a drug often prescribed under the brand name Coumadin[®] [Bristol-Myers Squibb Company]).

Are there any warnings associated with the use of FLOMAX?

FLOMAX may cause a sudden drop in blood pressure, especially following the first dose or when changing doses. Although rare, this drop in blood pressure may be associated with fainting, lightheadedness or dizziness. Caution should be

exercised when driving, operating machinery, or performing hazardous tasks, since injury could result.

What are the most common side effects of FLOMAX?

The most common side effects are dizziness, runny nose, and a decrease in semen. Other side effects include headache and tiredness.

How should I take FLOMAX?

FLOMAX 0.4 mg capsules are taken once daily. FLOMAX should be taken approximately one-half hour after the same meal each day. If you stop or forget to take FLOMAX for several days, start again with the 0.4 mg once-daily dose. If you were previously on a higher dose, contact your doctor before returning to the higher dose.

Do not crush, chew, or open FLOMAX capsules.

What about overdosing with FLOMAX?

You should always take your medications according to the directions given by your doctor. If you think you have taken an overdose of FLOMAX capsules, contact your doctor immediately.

Still have questions?

For more information, ask your doctor or pharmacist, call 1-866-432-9734, and/or visit www.4FLOMAX.com.

R_x only

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ROCK AND ROLL

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WITH THE RIGHT UPGRADES, your car can sound as good as an audiophile's living room and be as connected as your office.

Start by swapping the old stereo for a PC that plays your entire music and movie library. Then add digital radio for static-free

reception. Top it off with audio signal processing that will make you swear there's a live band on your dash.—BEN OH



SURF IN THE CAR

Though no larger than a double-high stereo, the Atlas CPC-1000 is a full Windows Vista PC with a 6.5-inch touchscreen and up to a 60-gigabyte hard drive (enough for about 15,000 songs). It can run iTunes, play games and movies, and provide GPS navigation. Add a cellular modem card for an always-on Internet connection.

Azentek Atlas CPC-1000
\$2,500; azentek.com

Want to build your own car computer instead? See page 92.



SET THE SOUNDSTAGE

The mix of materials and shapes inside a car plays havoc with its acoustics. Alpine's PXE-H650 is the first car audio processor with a microphone to measure these sonic problems and custom-adjust your speakers' output. It automatically optimizes settings for a full car or a solo driver. **Alpine PXE-H650 \$450; alpine-usa.com**



ADD AN AMP—EASILY

An aftermarket amplifier can massively boost the sound power of even flimsy stock speakers. And now you don't need a shop to install one. Order the THA 475 with one of 40 wire harnesses (covering about 2,000 car models), and you can have the four-channel, 75-watt amp bumping in less than an hour. **Blaupunkt THA 475 \$400; blaupunkt.com**



UPGRADE YOUR BROADCASTS

Hybrid digital radio offers near-CD-quality audio, now broadcast on 1,700 channels in the U.S. from both traditional stations and new digital-only offshoots. And unlike satellite radio, it's free. Visteon's HD Jump, one of the first car units, also plugs into a home docking kit. **Visteon HD Jump \$250; visteon.com**



CONNECT ANYTHING

Some factory stereos are inextricably linked to a car's data and electrical systems. But you can still expand your setup by installing the Kenwood KOS-V1000 hub. Its two USB ports and pair of A/V inputs and outputs let you add an iPod, HD radio and satellite-radio tuners, disc changers, LCD monitors, or even a game console. **Kenwood KOS-V1000 \$700; kenwoodusa.com**

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*Earn unlimited cash rewards on all purchases. Earn a full 5% Cashback Bonus on your first \$1,200 in annual gas and auto maintenance purchases. In addition, earn a full 1% on all other purchases after your total annual purchases (including gas and auto maintenance) exceed \$3,000; other purchases that are part of your first \$1,500 earn .25% and other purchases that are part of your second \$1,500 earn .50%. Combined gas and auto maintenance purchases in excess of \$1,200 earn Cashback Bonus at the same rate as other purchases. Gas and auto maintenance purchases are those made at merchants we classify as gas stations and at stores that primarily sell automotive parts and services, such as auto dealerships, auto repair shops, tire stores and car washes. Purchases made at select warehouse clubs, discount stores and their affiliates earn .25%. Rewards are redeemable in \$20 increments. Full terms and conditions will be sent with your Card.

**Purchase and Balance Transfer APRs are 0% until the last day of the billing period ending during May 2008. Standard purchase APR: variable 13.99%. Cash APR: 20.99% or 22.99%. Default APR: up to 28.99%. Min. fin. chg.: \$.50. Cash transaction fee: 3%, min. \$.50 and no max. Balance transfer fee: 3%, min. \$.50, max. \$.50. Rates as of March 1, 2007.

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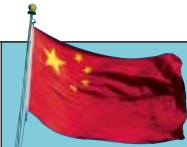
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A machine that turns Army trash into energy



THE FUTURE OF ENERGY

NUKING NUCLEAR WASTE

Energy officials argue for a new breed of reactors that run on recycled radioactive fuel



LATER THIS YEAR, scientists at Oak Ridge National Laboratory in Tennessee hope to take a big step toward solving America's nuclear-waste woes. Pending clearance from the Department of Energy, they will demonstrate a new toxic-waste recycling process.

The aim of the demo—part of a controversial \$405-million government project called the Global Nuclear Energy Partnership (GNEP)—is to transform nuclear leftovers into fuel for a new breed of reactors. The new reactor/fuel combo, GNEP officials say, could produce up to 100 times as much energy as conventional reactors and could generate 40 percent less waste.

WHAT A WASTE By 2015, 42 of the 103 nuclear reactors in the U.S. will run out of space to store spent fuel. Clockwise from left: Nevada Nuclear Test Site near Yucca Mountain; nuclear waste at the Hanford Site in Washington; a cooling tower.

The initiative is a key part of the Bush administration's long-term strategy to meet America's rising demand for electricity—according to the DOE, it's expected to jump by 45 percent from 4,000 billion kilowatt-hours in 2005 to 5,800 billion kilowatt-hours in 2030—without creating more greenhouse gases. "Nuclear energy is the biggest source we have for meeting our energy needs without contributing to global warming," says Sherrell Greene, director of the nuclear-technology program at Oak

Ridge, one of the 13 potential recycling sites selected earlier this year by the DOE.

Another central GNEP objective is to deal with the nation's growing nuclear-waste problem: The country's 103 nuclear reactors produce 2,200 tons of radioactive waste annually, and there's no good place to put it. Even if no new reactors are built, at current rates, the U.S. will have produced more than 94,600 tons of spent nuclear fuel by 2050, and the repository at Yucca Mountain in Nevada, America's ►

MILITARY TECH

BEACH CLEANUP

A naval strategy to detonate 70 million mines calls for high-tech showers of darts

SINCE 2001, more than 13,000 American soldiers have been killed or maimed by landmines or improvised explosive devices. Civilians included, landmines kill or injure an estimated 20,000 people around the world every year. To blaze safer trails, the U.S. Office of Naval Research is developing a system that uses thousands of chemical- and explosive-packed darts to snuff out landmines. "It's one of the most successful systems we've tested so far," says project leader Brian Almquist.

Mines are often equipped with a touch or tilt trigger, making them extremely difficult to safely defuse by hand or by robot, and the current method for clearing mines from a safe distance—dropping a large blast warhead on the field—works only on ones laid aboveground. The new system circumvents these problems by employing a cylindrical bombshell packed with 6,500 darts.

When dropped from the safety of an airplane, the GPS-guided bomb

ejects the darts and spreads them out in a 60-foot circular pattern. Each dart is designed to burrow several feet into sand or water, pierce the exterior of a mine, and defuse or detonate it. For safety reasons, any explosive darts that don't hit mines self-sterilize.

Almquist and his team are still modifying the darts, and the project needs approval from the Naval Sea Systems Command Acquisition Program to move out of the lab, but a fieldable system could be ready by 2015.—BJORN CAREY





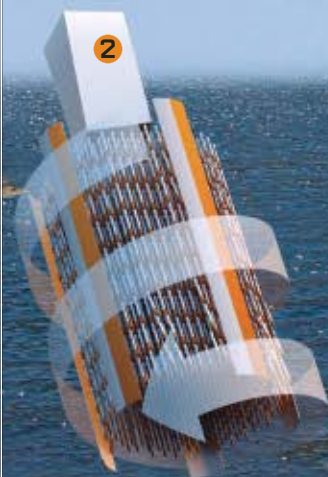
HOW IT WORKS

1 A plane drops a bomb packed with darts. Once it reaches 1,000 feet above its target, the bomb ejects a seven-foot-long tubular canister.

2 A corkscrew pattern carved into the bomb's interior spins the canister as it slides out, like a bullet leaving a gun. The rotation and small explosives jettison the canister's panels and expose 6,500 darts stacked several rows deep. The mass of darts is also spinning, which uniformly disperses them.

3 Each seven-inch dart slams into the ground at 1,200 feet per second. Its blunt nose helps it carve a channel in water or sand, a process called cavitation. This reduces friction on the body of the dart and allows it to pass through two feet of sand and more than seven feet of water.

4 Darts inject the mines with one of three substances: a chemical that safely burns the TNT, a reactive powder that breaks apart the mine by increasing internal pressure, or a small explosive that detonates the mine on impact.



lone long-term solution to radioactive-waste storage, will stow just 77,000 tons when it's slated to open in 2020.

Yet not everyone thinks GNEP's strategy for recycling waste is the solution. Ivan Oelrich of the Federation of American Scientists, for example, says that the new type of recycled fuel would contain as much as 90 percent plutonium, making it a much more attractive target to a bomb-building terrorist. Spent fuel from traditional reactors, by comparison, contains only 1 percent plutonium.

GNEP officials reject this criticism. The new recycling process, they argue,

New reactors could produce 40 percent less waste than conventional ones.

will not isolate pure plutonium, making it more difficult to convert the leftovers into a bomb. Specifically, the process calls for dissolving spent fuel in nitric acid to chemically extract the nastiest 1 percent—the highly radioactive elements plutonium, neptunium, americium and curium, also known as actinides—as well as depleted uranium. (The remaining waste is stored in traditional casks.) The uranium is then re-enriched, recombined with the actinides, and compressed into fuel pellets for state-of-the-art reactors. In this scheme, waste is used repeatedly, transforming it into less harmful elements with each cycle.

The Oak Ridge demonstration is intended to be a miniature model (minus the reactors) of how this recycling process could work at the industrial scale. "It's a synthesis of the whole process," says Greene, who is working on the project.

In addition to pursuing scaled-down tests of the new recycling technology, GNEP officials will release a draft report this summer on the environmental impact of the potential sites. But the program's defining moment will happen next year when the U.S. secretary of energy decides whether to step up the initiative and build America's first full-scale demonstration plant.—SETH FLETCHER

**WIRELESS
HIGH SPEED.**



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WHO ISN'T MOON-BOUND?

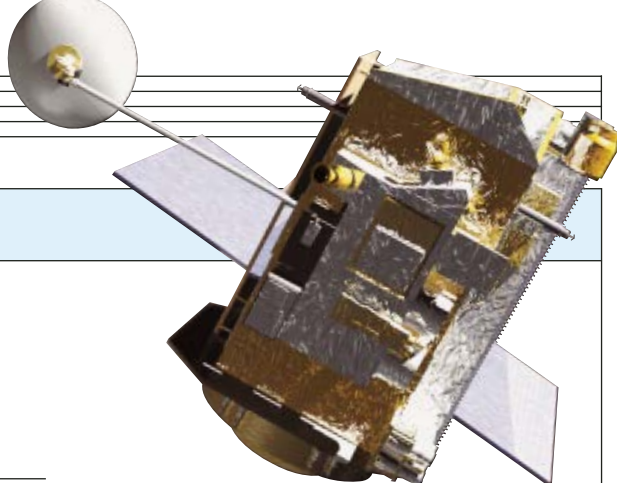
China launches its first lunar orbiter, *Chang'e 1*, this spring, kicking off a second space race

THE NEXT TWO YEARS will see a blitz of activity around the moon, as spacecraft from China, Japan, India and the U.S. point cameras, spectrometers and other instruments at the lunar surface.

All four orbiters will scout sites for potential moon bases, hunting for water at the lunar poles and for pockets of mission-sustaining elements such as aluminum, oxygen and helium. According to Paul Spudis, a lunar expert at Johns Hopkins University's Applied Physics Laboratory and the lead scientist for the American imaging-radar experiment on India's satellite, each of the nations has serious ambitions to put their scientists on the moon. "Sending satellites is a logical first step," he says.

But there's more at stake than national pride—by broadening their space experience and displaying technological prowess, each country stands to lure lucrative contracts with companies looking to launch satellites. Although the overlapping objectives could allow scientists to cross-check data as it's radioed back by the orbiters, so far there's been little cooperation among the competing space agencies. "The missions were not planned on the basis of a coordinated strategy," Spudis says. To wit: India and the U.S. have agreed to share data, but Japan has not indicated that it will do the same, and China's space program is notoriously secretive. The race is on—may the best robot win.—DAWN STOVER

TEAM U.S.A. Measuring deadly cosmic rays is among the many objectives of NASA's *Lunar Reconnaissance Orbiter*.



NATION	CRAFT	MISSION	SIGNIFICANCE	SCHEDULED LAUNCH
	China National Space Administration's <i>Chang'e 1</i> (named after a Chinese goddess who ingests a magic potion and flies to the moon)	Circle the moon for a year and snap 3-D pictures of the surface, study its composition, and measure the thickness of the lunar soil	As China's first moon flight, this mission will pave the way for robotic landers and human exploration.	This spring
	Japan Aerospace Exploration Agency's SElenological and ENgineering Explorer (<i>SELENE</i> , the Greek goddess of the moon)	Map the moon's surface and subsurface. Two subsatellites will help measure the moon's gravitational field and the remnant of its magnetic field	Data produced by this orbiter will help scientists determine whether the moon formed from rocks surrounding an early Earth or from scattered Earth fragments.	This summer
	Indian Space Research Organization's <i>Chandrayaan-1</i> (Hindi and Sanskrit for "moon vehicle")	Produce maps of the moon's topography and mineral composition, search for water ice at the lunar poles, and drop an impactor probe	The craft, India's first mission to the moon, will also be the first to carry an imaging-radar instrument to the moon—useful in the search for water ice.	Early next year
	NASA's <i>Lunar Reconnaissance Orbiter</i>	Look for water ice near the surface, measure temperature and sunlight at the poles, and scout landing sites for future missions	This is the first phase in NASA's Robotic Lunar Exploration Program, which will lay the groundwork for a manned moon base.	Next October

THE SLEEP YOU'VE BEEN DREAMING OF.



SOOTHING REST FOR MIND AND BODY.

It's what you've been craving. Peaceful sleep without a struggle. That's what

LUNESTA® is all about: helping most people fall asleep quickly, and stay asleep all through the night. It's not only non-narcotic, it's approved for long-term use. So you can feel comfortable taking it night after night. Talk to your doctor first before using sleep aids for extended periods. Tonight, just close your eyes, and *leave the rest to Lunesta.*

Find out how to improve your sleep habits at www.lunesta.com. Or call 1-800-Lunesta.

Lunesta
(eszopiclone)
1, 2 AND 3 MG TABLETS

IMPORTANT SAFETY INFORMATION: LUNESTA works quickly, and should be taken right before bed. Be sure you have at least eight hours to devote to sleep before becoming active. Until you know how you'll react to prescription LUNESTA, you should not drive or operate machinery. Do not use alcohol while taking LUNESTA. Most sleep medicines carry some risk of dependency. Side effects may include unpleasant taste, headache, drowsiness and dizziness. See important patient information on the next page.

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Please read this summary of information about LUNESTA before you talk to your doctor or start using LUNESTA. It is not meant to take the place of your doctor's instructions. If you have any questions about LUNESTA tablets, be sure to ask your doctor or pharmacist.

LUNESTA is used to treat different types of sleep problems, such as difficulty in falling asleep, difficulty in maintaining sleep during the night, and waking up too early in the morning. Most people with insomnia have more than one of these problems. You should take LUNESTA immediately before going to bed because of the risk of falling.

LUNESTA belongs to a group of medicines known as "hypnotics" or, simply, sleep medicines. There are many different sleep medicines available to help people sleep better. Insomnia is often transient and intermittent. It usually requires treatment for only a short time, usually 7 to 10 days up to 2 weeks. If your insomnia does not improve after 7 to 10 days of treatment, see your doctor, because it may be a sign of an underlying condition. Some people have chronic sleep problems that may require more prolonged use of sleep medicine. However, you should not use these medicines for long periods without talking with your doctor about the risks and benefits of prolonged use.

Side Effects

All medicines have side effects. The most common side effects of sleep medicines are:

- Drowsiness
- Dizziness
- Lightheadedness
- Difficulty with coordination

Sleep medicines can make you sleepy during the day. How drowsy you feel depends upon how your body reacts to the medicine, which sleep medicine you are taking, and how large a dose your doctor has prescribed. Daytime drowsiness is best avoided by taking the lowest dose possible that will still help you sleep at night. Your doctor will work with you to find the dose of LUNESTA that is best for you. Some people taking LUNESTA have reported next-day sleepiness.

To manage these side effects while you are taking this medicine:

- When you first start taking LUNESTA or any other sleep medicine, until you know whether the medicine will still have some effect on you the next day, use extreme care while doing anything that requires complete alertness, such as driving a car, operating machinery, or piloting an aircraft.
- Do not drink alcohol when you are taking LUNESTA or any sleep medicine. Alcohol can increase the side effects of LUNESTA or any other sleep medicine.
- Do not take any other medicines without asking your doctor first. This includes medicines you can buy without a prescription. Some medicines can cause drowsiness and are best avoided while taking LUNESTA.
- Always take the exact dose of LUNESTA prescribed by your doctor. Never change your dose without talking to your doctor first.

Special Concerns

There are some special problems that may occur while taking sleep medicines.

Memory Problems

Sleep medicines may cause a special type of memory loss or "amnesia." When this occurs, a person may not remember what has happened for several hours after taking the medicine. This is usually not a problem since most people fall asleep after taking the medicine. Memory loss can be a problem, however, when sleep medicines are taken while traveling, such as during an airplane flight and the person wakes up before the effect of the medicine is gone. This has been called "traveler's amnesia." Memory problems have been reported rarely by patients taking LUNESTA in clinical studies. In most cases, memory problems can be avoided if

you take LUNESTA only when you are able to get a full night of sleep before you need to be active again. Be sure to talk to your doctor if you think you are having memory problems.

Tolerance

When sleep medicines are used every night for more than a few weeks, they may lose their effectiveness in helping you sleep. This is known as "tolerance." Development of tolerance to LUNESTA was not observed in a clinical study of 6 months' duration. Insomnia is often transient and intermittent, and prolonged use of sleep medicines is generally not necessary. Some people, though, have chronic sleep problems that may require more prolonged use of sleep medicine. If your sleep problems continue, consult your doctor, who will determine whether other measures are needed to overcome your sleep problems.

Dependence

Sleep medicines can cause dependence in some people, especially when these medicines are used regularly for longer than a few weeks or at high doses. Dependence is the need to continue taking a medicine because stopping it is unpleasant.

When people develop dependence, stopping the medicine suddenly may cause unpleasant symptoms (see *Withdrawal* below). They may find they have to keep taking the medicine either at the prescribed dose or at increasing doses just to avoid withdrawal symptoms.

All people taking sleep medicines have some risk of becoming dependent on the medicine. However, people who have been dependent on alcohol or other drugs in the past may have a higher chance of becoming addicted to sleep medicines. This possibility must be considered before using these medicines for more than a few weeks. If you have been addicted to alcohol or drugs in the past, it is important to tell your doctor before starting LUNESTA or any sleep medicine.

Withdrawal

Withdrawal symptoms may occur when sleep medicines are stopped suddenly after being used daily for a long time. In some cases, these symptoms can occur even if the medicine has been used for only a week or two. In mild cases, withdrawal symptoms may include unpleasant feelings. In more severe cases, abdominal and muscle cramps, vomiting, sweating, shakiness, and, rarely, seizures may occur. These more severe withdrawal symptoms are very uncommon. Although withdrawal symptoms have not been observed in the relatively limited controlled trials experience with LUNESTA, there is, nevertheless, the risk of such events in association with the use of any sleep medicine.

Another problem that may occur when sleep medicines are stopped is known as "rebound insomnia." This means that a person may have more trouble sleeping the first few nights after the medicine is stopped than before starting the medicine. If you should experience rebound insomnia, do not get discouraged. This problem usually goes away on its own after 1 or 2 nights.

If you have been taking LUNESTA or any other sleep medicine for more than 1 or 2 weeks, do not stop taking it on your own. Always follow your doctor's directions.

Changes In Behavior And Thinking

Some people using sleep medicines have experienced unusual changes in their thinking and/or behavior. These effects are not common. However, they have included:

- More outgoing or aggressive behavior than normal
- Confusion
- Strange behavior
- Agitation
- Hallucinations
- Worsening of depression
- Suicidal thoughts

How often these effects occur depends on several factors, such as a person's general health, the use of other medicines, and which sleep medicine is being used. Clinical experience with LUNESTA suggests that it is rarely associated with these behavior changes.

It is also important to realize it is rarely clear whether these behavior changes are caused by the medicine, are caused by an illness, or have occurred on their own. In fact, sleep problems that do not improve may be due to illnesses that were present before the medicine was used. If you or your family notice

any changes in your behavior, or if you have any unusual or disturbing thoughts, call your doctor immediately.

Pregnancy And Breastfeeding

Sleep medicines may cause sedation or other potential effects in the unborn baby when used during the last weeks of pregnancy. Be sure to tell your doctor if you are pregnant, if you are planning to become pregnant, or if you become pregnant while taking LUNESTA.

In addition, a very small amount of LUNESTA may be present in breast milk after use of the medication. The effects of very small amounts of LUNESTA on an infant are not known; therefore, as with all other prescription sleep medicines, it is recommended that you not take LUNESTA if you are breastfeeding a baby.

Safe Use Of Sleep Medicines

To ensure the safe and effective use of LUNESTA or any other sleep medicine, you should observe the following cautions:

1. LUNESTA is a prescription medicine and should be used ONLY as directed by your doctor. Follow your doctor's instructions about how to take, when to take, and how long to take LUNESTA.
2. Never use LUNESTA or any other sleep medicine for longer than directed by your doctor.
3. If you notice any unusual and/or disturbing thoughts or behavior during treatment with LUNESTA or any other sleep medicine, contact your doctor.
4. Tell your doctor about any medicines you may be taking, including medicines you may buy without a prescription and herbal preparations. You should also tell your doctor if you drink alcohol. DO NOT use alcohol while taking LUNESTA or any other sleep medicine.
5. Do not take LUNESTA unless you are able to get 8 or more hours of sleep before you must be active again.
6. Do not increase the prescribed dose of LUNESTA or any other sleep medicine unless instructed by your doctor.
7. When you first start taking LUNESTA or any other sleep medicine, until you know whether the medicine will still have some effect on you the next day, use extreme care while doing anything that requires complete alertness, such as driving a car, operating machinery, or piloting an aircraft.
8. Be aware that you may have more sleeping problems the first night or two after stopping any sleep medicine.
9. Be sure to tell your doctor if you are pregnant, if you are planning to become pregnant, if you become pregnant, or if you are breastfeeding a baby while taking LUNESTA.
10. As with all prescription medicines, never share LUNESTA or any other sleep medicine with anyone else. Always store LUNESTA or any other sleep medicine in the original container and out of reach of children.
11. Be sure to tell your doctor if you suffer from depression.
12. LUNESTA works very quickly. You should only take LUNESTA immediately before going to bed.
13. For LUNESTA to work best, you should not take it with or immediately after a high-fat, heavy meal.
14. Some people, such as older adults (i.e., ages 65 and over) and people with liver disease, should start with the lower dose (1 mg) of LUNESTA. Your doctor may choose to start therapy at 2 mg. In general, adults under age 65 should be treated with 2 or 3 mg.
15. Each tablet is a single dose; do not crush or break the tablet.

Note: This summary provides important information about LUNESTA. If you would like more information, ask your doctor or pharmacist to let you read the Prescribing Information and then discuss it with him or her.

Rx only





FIGHTING BAD TASTE

Food scientist Mark Zoller is engineering chemicals that can fool Americans into eating healthier. Mmm, brussels sprouts. . .

SUGAR AND SALT are mainstays in food because they mask ingredients that taste bad. Cola without sweetener, for example, would be a bitter brew, thanks to its caffeine kick. Now chemist Mark Zoller and his group at the biotechnology startup Senomyx in San Diego have developed chemicals that could reduce the amount of salt, MSG and sugar necessary in chips, crackers, soda—any edible item, really—by 40 percent. Think of Senomyx's additives (currently in tests with food-industry biggies Coca-Cola and Nestle, among others) as anti-flavors: molecules that alter taste receptors and trick the brain into thinking that a food tastes better than it really does. The first products containing Senomyx's "savory flavor enhancers," ingredients that reduce the need for MSG in processed food, could debut as soon as this month. The company won't disclose which products will contain their ingredients—nor will you be able to figure it out for yourself, since their quantities don't warrant reporting—but watch nutrition labels for a drop in MSG. We chatted with Zoller about the science of taste and whether chemicals can truly clean up our diet.

—ADAM LASHINSKY

Q: Senomyx has begun commercializing four compounds to enhance or block taste receptors. How do they work?

A: A taste receptor is something that binds the taste ingredient, like sugar, to cells in your mouth. If your sweet cell gets activated, the message is sent to the brain, which tells you that something tastes sweet. Our process allows us to turn the receptor on or off.

Q: So by turning off a tongue receptor for, say, bitterness, a food that previously was loaded with sugar to mask the bitterness could have less sugar?

A: Exactly. Processed foods have high levels of salt and sugar, so if we could reduce those, improve the nutritional profile, and have the food taste just as good, then there's a benefit to the consumer.

Q: You've patented a new approach to engineering artificial flavors. What makes it different?

A: All the high-potency artificial flavors on the market today have been found because somebody just licked their fingers and tested them. We've basically made an artificial taste bud with an artificial taste receptor. If a chemical contacts and binds to the receptor, then we know it has an individual flavor. ▶

JUST EAT IT Zoller's bitter-blocking chemicals could help make kids eat their vegetables.



“WITH OUR INGREDIENTS, FOOD WILL NEED LESS SALT AND SUGAR BUT STILL TASTE GOOD.”

Q: Have you tried the bitter blockers?

A: Yes, but I'm not yet allowed to talk about how they taste.

Q: Are your ingredients safe?

A: Yes. Like all artificial flavors, they'll be used in very low levels and approved by the Food and Drug Administration.

Q: Instead of pursuing food science, couldn't we just educate people to reduce their sodium and sugar intake?

A: The problem with salt, for example, is that food just doesn't taste good without it. Food needs a certain level of saltiness or people don't like it. Maybe food companies can reduce sodium by 25 percent. But it doesn't taste very good.

In a perfect world, people would modify their behavior to eat food that isn't as tasty, but taste drives what people eat.

Q: Are taste receptors universal?

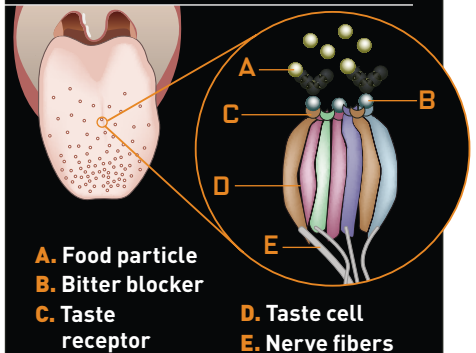
A: No. Some people taste the sweetener saccharin as sweet, and other people taste it as both sweet and bitter. It's because they have a certain bitter receptor that responds to saccharin. We can turn off that bitter receptor.

Q: Is synthetic flavor the future of food?

A: We're not limited to artificial ingredients. We're also pursuing natural ingredients. We certainly don't have a project aiming at completely synthetic food. I like food. I like the way it tastes.

IMPROVING TASTE

THE TONGUE is home to more than 10,000 taste buds. Each bud consists of a bundle of cells that detect chemicals in food and drink. New flavor enhancers bind to these cells to magnify the brain's perception of tastes, such as sweet and salty. This effect will enable manufacturers to reduce sugar and sodium in their products without compromising flavor.



essential₂unlo

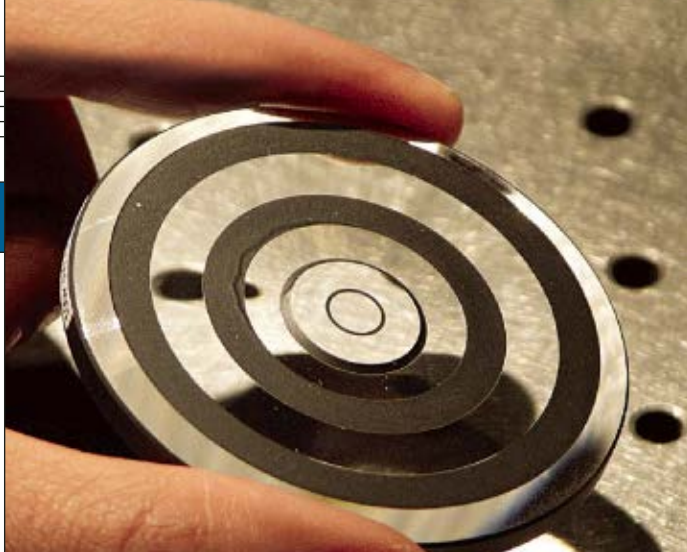
ORIGAMI OPTICS

A new optic promises better zoom capability for even the thinnest cameraphones

CELLPHONE DESIGNERS STRIVE for sleekness, a quality that makes it nearly impossible to include a quality zoom lens on your phone. The thin, wide-angle lenses found in today's phones work fine for panoramic shots, but forget about crisp close-ups. To zoom in, cellphone cams simply stretch pixels, which kills image quality.

Now researchers at the University of California at San Diego have borrowed a mirror trick from reflective-telescope makers to cram sharp telephoto capability into a package just a few millimeters thick. The technique uses mirrors to bounce light back and forth, lengthening the path light travels (which increases the potential for magnification) without bulking up the length of the optic.

To make the lens, engineering professor Joseph Ford and graduate student Eric Tremblay carved an array of concentric reflective rings into a single optical crystal, creating a minia-



SLIMMING MIRRORS The reflective rings on this crystal increase the optic's focal length to enable high-quality zoom.

ture hall of mirrors. When light enters the camera's aperture, it bounces from ring to ring and eventually lands on a central sensor that interprets the information and produces close-up telephoto images on your screen. The new optic is seven times as thin as a traditional, 35-millimeter refractive lens, with nearly equivalent image quality.

The researchers have applied for a patent on the technology and are working on a version of the optic that's one fifth the current size—which could be good news for your cameraphone in a couple years.—ERIC MIKA

ckingsecrets

It is one in every eight patents and \$24 billion invested in research each year. It is chemistry.

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2006 American Le Mans Series GT2 Class Manufacturers' Champion



Preferred Technical Partner of Porsche

2006. Yet another great year.

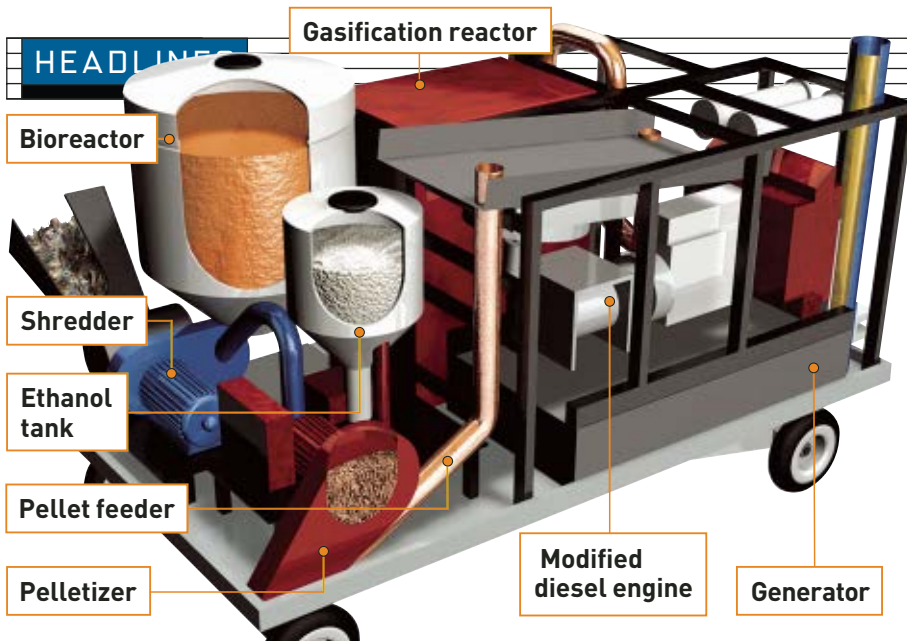
Michelin® tires captured the 2006 Formula One Driver's and Manufacturers' Titles; the MotoGP Championship; the top 13 positions at the 24 Hours of Le Mans; and a sweep of Manufacturers', Team, Driver, and Tire Championships in all American Le Mans Series classes. No other tire maker came even close to this record in open competition last year.

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INVENTION OF THE MONTH

JUNK IN, POWER OUT

A mobile bioreactor turns trash into electricity for U.S. troops

THE COW IS a model power generator: Each day it expels enough methane to run your home furnace for 24 hours. At Purdue University, a team of nearly two dozen researchers has built a portable device that mimics this natural metabolic process to create electricity. The “biorefinery,” which is three years and \$850,000 in the making, can digest ordinary kitchen scraps and other trash to produce ethanol and a composite gas and use them to fuel an electrical generator.

The device was designed for the U.S. Army, which solicited researchers for ways to slash the amount of fuel it uses to run diesel generators and to reduce the output of garbage from a typical 600-person field support unit. (An Army soldier produces an average of four pounds of trash a day.) “We wanted a twofer,” says Jerry Warner, founder of Defense Life Sciences, a private contractor that partnered with the Purdue scientists. “Get rid of the trash and conserve fuel at the same time.”

The refinery works like a giant digestive tract. After a shredder chews up trash, enzymes digest it into simple sugars, which yeast metabolizes to produce ethanol. Any leftover waste (paper cups, plastic forks and so on) is packed into pellets and burned to produce a gas composed primarily of methane, propane, carbon dioxide and hydrogen.

HOW IT WORKS

- STEP 1:** The shredder rips up waste and soaks it in water.
- STEP 2:** The sludge is pumped into the bioreactor, and enzymes break it down into carbohydrates and then into simple sugars, which yeast metabolizes into ethanol.
- STEP 3:** The pelletizer compresses undigested waste into pellets and feeds them into a gasification reactor that burns them to produce a composite gas.
- STEP 4:** The ethanol is combined with the composite gas and injected into a diesel generator, where it's mixed with 10 percent diesel fuel to generate electricity.

The refinery blends this gas with the ethanol and uses it to run a modified diesel generator.

About the size of a moving van, the biorefinery is entirely self-contained and self-powered. Feed it 2,500 pounds of trash a day, and it pumps out enough electricity (60 kilowatts) to run a large mess-tent operation or three homes.

The biorefinery could also be housed in a large office building or hospital, where excess thermal energy could be used to heat water. Or it could be dispatched to a disaster area and pull double duty, helping clean up the mess and lighting a city left in the dark.

Warner and the Purdue team demonstrated the machine for Army officials last November and are building a second prototype to test later this year.—MICHAEL BEHAR

PAUL WOOTTON



We consider endurance racing nothing less than the world's greatest test track for street tires. For the 9th consecutive year, the winner of the ultimate endurance race, the 24 Hours of Le Mans, rode on Michelin® tires. Not surprisingly, our street tires are just as remarkable. The Michelin® Pilot® Series tires have the highest combined levels of performance in the category.* Go to michelinman.com/performance.



THE EDGE IS NEVER DULL.

ALL-NEW EDGE With attention-grabbing styling and unique features like an available panoramic Vista Roof,[™] this crossover is designed to inspire you to view the world in a different way. Plus, it offers the punch of class-leading* 265 horsepower and does it all with impressive fuel economy.** So, stay sharp with the Edge, starting at \$25,995 MSRP.[†] And leave dull behind.



BOLD MOVES
fordvehicles.com/edge

*Class is medium-size crossovers with standard V6. **EPA estimated 18 city/25 hwy mpg. FWD. [†]SE \$25,995; as shown, SEL \$30,135. Taxes, title and license fees extra.

DRIVING OUR FUTURE

AUTOMOTIVE BREAKTHROUGHS are an almost daily event, if you believe the press coming out of the car industry. The 2006 auto-show circuit showcased eight-speed automatics, high-res night vision, zero-lag turbos and a dozen other hyphenated doodads. But real automotive breakthroughs—the ones that transform the industry, and our hopes for it—are rare. We're here to show you a few of them.

This issue is about the breakthroughs that will fundamentally change what it means to drive a car in America. It's about whether we'll soon be filling up with ethanol or biodiesel or hydrogen, or none of the above [page 76]. It's about the guy who's proving that, with the right technology, electric cars can not only be practical, they can also win the hearts of the performance-hungry by being faster off the line than a gasoline-powered supercar [page 68]. It's about the quest to build robots that drive for us, even in the most complicated situations [page 58]. It's about the brave little microcar and its fight to earn a place on the big, bad American highway [page 82].

Not everything we predict on these pages will come to pass. But the auto industry is changing fast, and we decided it was time to present the breakthroughs so big that one day you might forget cars were built any other way.



TURN THE PAGE FOR OUR CATALOG OF THE VEHICLES OF TOMORROW, READY FOR DELIVERY IN 2027



CATEGORY: SPORT PERFORMANCE

**BREAKTHROUGH TECH: ELECTRIC HUB MOTORS,
FOUR-SEAT AERODYNAMIC POD**

JAVELIN SPEEDSLED

SUPERCAR SEATS FOUR

No longer must drivers confine themselves to the limitations of conventional sports cars, with cramped interiors, aerodynamically compromised styling and body-battering ground clearances. The new all-electric sport cruiser's performance-tuned suspension cuts aggressively through turns, while its four powerful hub motors—individual electric motors built into the wheels that generate a combined 450 horsepower—send it blasting down straights, reaching 60 mph in less than four seconds on its way to a top speed of 200 mph. But the real innovation is its aerodynamics: Instead of fighting high-speed airflow, the car takes advantage of it, channeling the air around the central, low-slung pod to generate huge downforce. Furthermore, the hub motors eliminate the need for a large engine, freeing space for three passengers to ride in a unique 1+2+1 seating configuration.

EXOSKELETON

Exposed structural components are shaped to reduce drag and direct airflow around the central passenger pod.

HIGH RIDE

The clean underbody and high-downforce aerodynamic pod permit higher ground clearance than conventional supercars. This generates a more comfortable ride without hindering high-speed performance.

WHEEL FAIRINGS

Streamlined pods minimize the tendency of exposed wheels to create lift.

SMART SEATING

Passenger pod minimizes drag with a tapered front and rear shape. Inside, you'll find an unusual 1+2+1 tandem-seating configuration.

WHEEL POWER

Four lightweight 85-kilowatt electric hub motors eliminate the need for a large engine. They also integrate shock absorbers, brakes and drive-by-wire steering controls into the wheels.

AERODYNAMIC MORPHING

Based on your preferences, front- and rear-wing surfaces morph to an ideal aerodynamic shape to either increase downforce or reduce drag, thereby improving efficiency.

VARIABLE COLOR

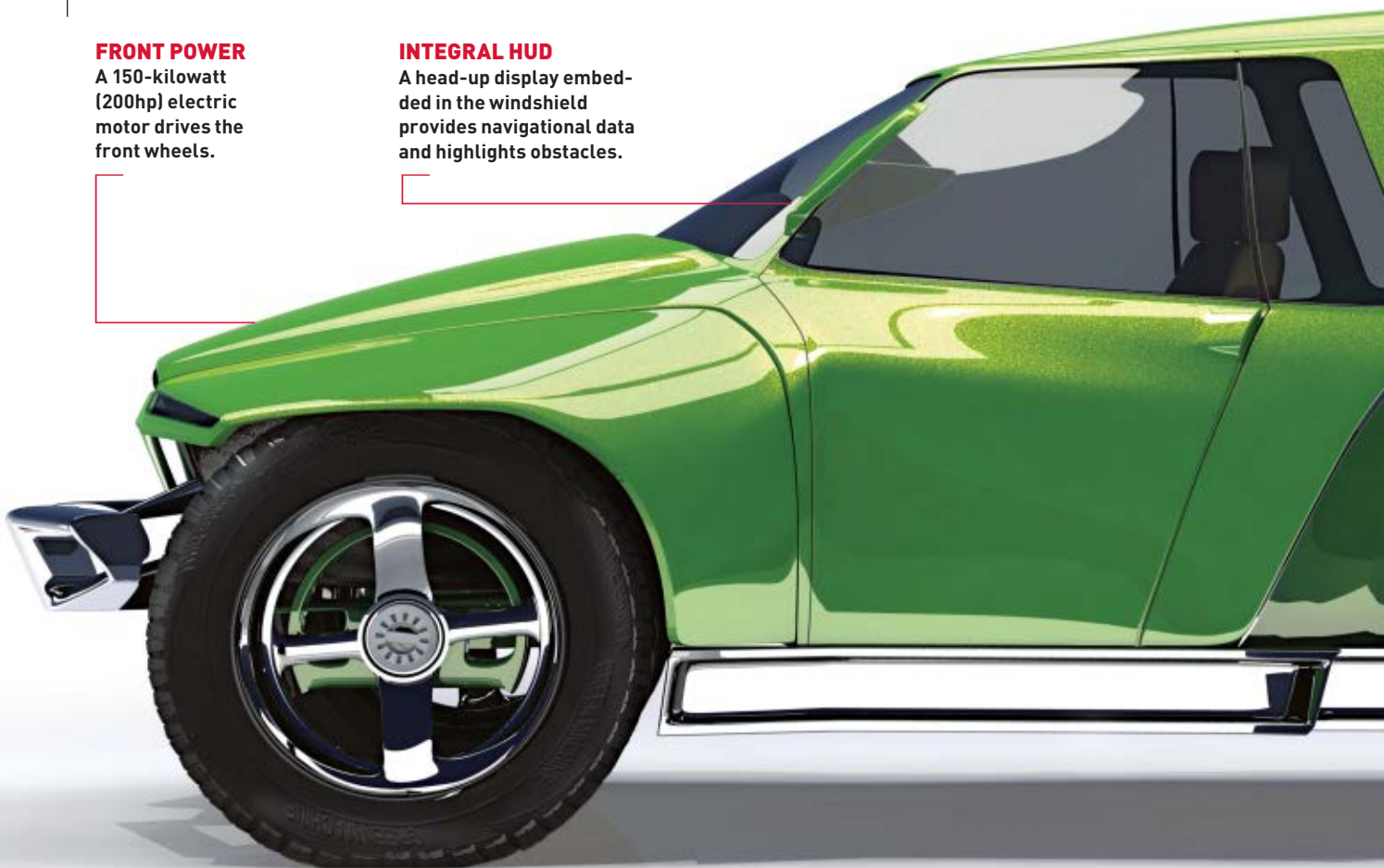
Electrochromic paint can be adjusted to any hue, with natural fades between colors. Program your car to cycle through color schemes as you accelerate.

FRONT POWER

A 150-kilowatt (200hp) electric motor drives the front wheels.

INTEGRAL HUD

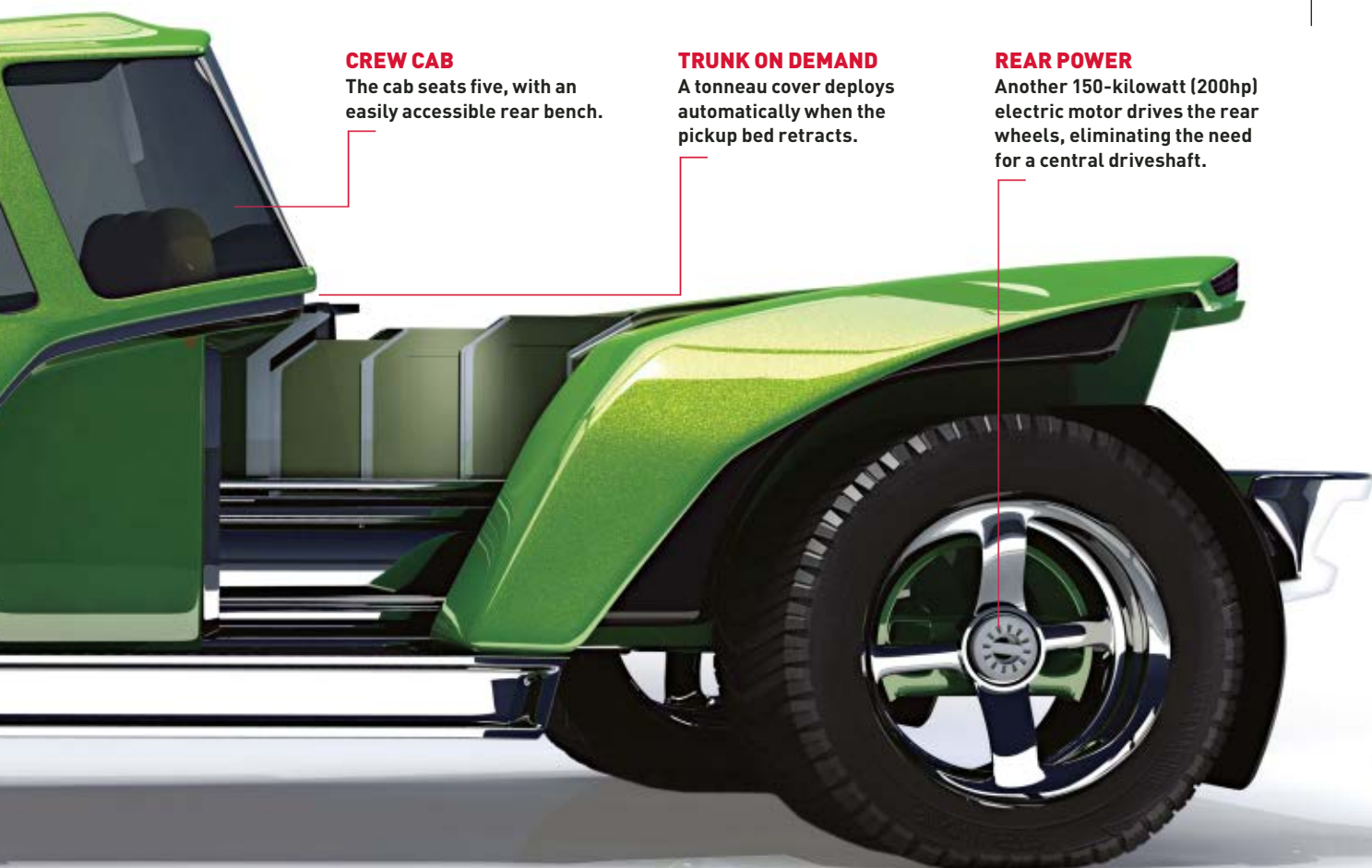
A head-up display embedded in the windshield provides navigational data and highlights obstacles.



COMPACT UTILITY

The retracted configuration permits tight maneuvering.



**CREW CAB**

The cab seats five, with an easily accessible rear bench.

TRUNK ON DEMAND

A tonneau cover deploys automatically when the pickup bed retracts.

REAR POWER

Another 150-kilowatt (200hp) electric motor drives the rear wheels, eliminating the need for a central driveshaft.

CATEGORY: **ADAPTIVE UTILITY**

BREAKTHROUGH TECH: **EXTENDABLE PAYLOAD BED, HIGH-POWER DRIVE MOTORS**

EXTENDER

E L A S T I C T R U C K

STRETCHING POSSIBILITIES

This truck fits your life. It's efficient, clean, tough as they come—and has one big trick up its sleeve. The Extender, a 400-horsepower, all-electric, four-wheel-drive monster (which uses the most powerful DC motors yet devised for the automotive industry), has an adjustable payload bed. When not in use, the bed retracts unobtrusively into the rear of the truck. It extends by way of an electric piston up to a full-size 4x8 bed with thin-but-sturdy armored sidewalls and a structural support system that can handle the toughest terrain and the heaviest loads.



CATEGORY: MODULAR DOMESTIC

BREAKTHROUGH TECH: BALANCING PODS,
AUTONOMOUS DRIVE, VERSATILE CONFIGURATION

SNAP!

MULTICAR

BREAKING UP IS EASY

Behold the most flexible family car ever devised. It's not just one car—it's two, or three or four. Imagine you're driving to the shore. Your daughter wants to see her friends, your son wants to surf, and you and your wife want to hit the boardwalk. No need to play taxi. This groundbreaking new sedan is made from four independently drivable pods. When attached as a single car, the side windows rotate open to allow for side-to-side interaction, with a high-fidelity microphone system for clear front-to-back conversation, as well. If the passengers want to split up, each driver enjoys either hand controls or, particularly for younger, not-yet-road-legal children, the latest in fully autonomous driving capabilities.

BIG WHEELS

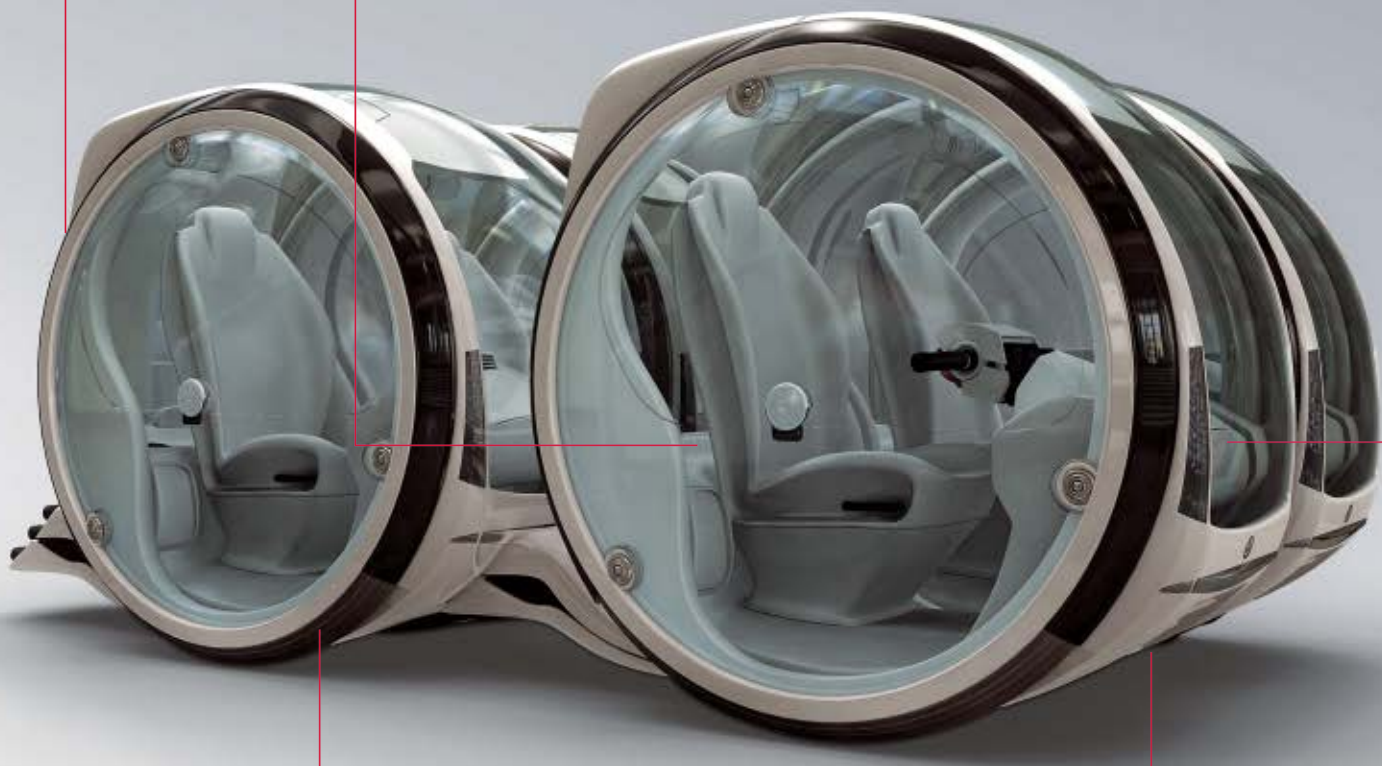
Two full-height, hub-motor-powered wheels frame each pod.

JOINING FORCES

Each pod has its own power source. When combined, the motors work together to drive the sedan. An onboard computer manages power to each motor.

BALANCING ACT

Individual pods balance with the help of accelerometers and gyroscopic sensors that detect instabilities and instantly adjust the relative speed of each wheel to keep you upright.



CORNERING ON RAILS

Individually and when connected, the pods steer by varying the relative speeds of the wheels—almost like a tank—or, at higher speeds, a slight pitching of each wheel to the left or right.

THIRD WHEEL

Because balanced driving for individual pods works best under 20 mph, a deployable third wheel extends from the front of each car to permit pods to safely reach 50 mph. Top speed of two or more pods joined together: 150 mph.



CATEGORY: **HEAVY TRANSPORT**

BREAKTHROUGH TECH: **DYNAMIC DISPLAYS, AUTONOMOUS DRIVE**

NOMAD

R O A D T R A I N

MAKES GETTING THERE HALF THE FUN

It's the first hands-off big rig. Need to send a shipment autonomously from Las Vegas to Tahoe? Program the route and schedule, and let it go. Need to bring a crew with you or have the added flexibility of a human driver who can handle tight maneuvering and cargo management and supervision? The Nomad can be customized for any business. Here, a professional racing team's truck comes complete with a luxurious crew deck upstairs, a fully functional garage workspace, and room for two racecars.

DIESEL GRUNT

700-horsepower clean-diesel engine underneath the crew deck generates enough power to haul 40-ton loads.

BUBBLE CANOPY

The wraparound windscreen automatically adjusts its tint in harsh sunlight.



CREW DECK

Cabin seats six or eight in comfortable chairs that recline to full beds. LCD and holographic entertainment systems, as well as a bathroom and kitchenette, come standard.

VARIABLE WINDOW

The floor-to-ceiling OLED windscreen on the crew deck can adjust from completely transparent to opaque for privacy.

EASY ACCESS

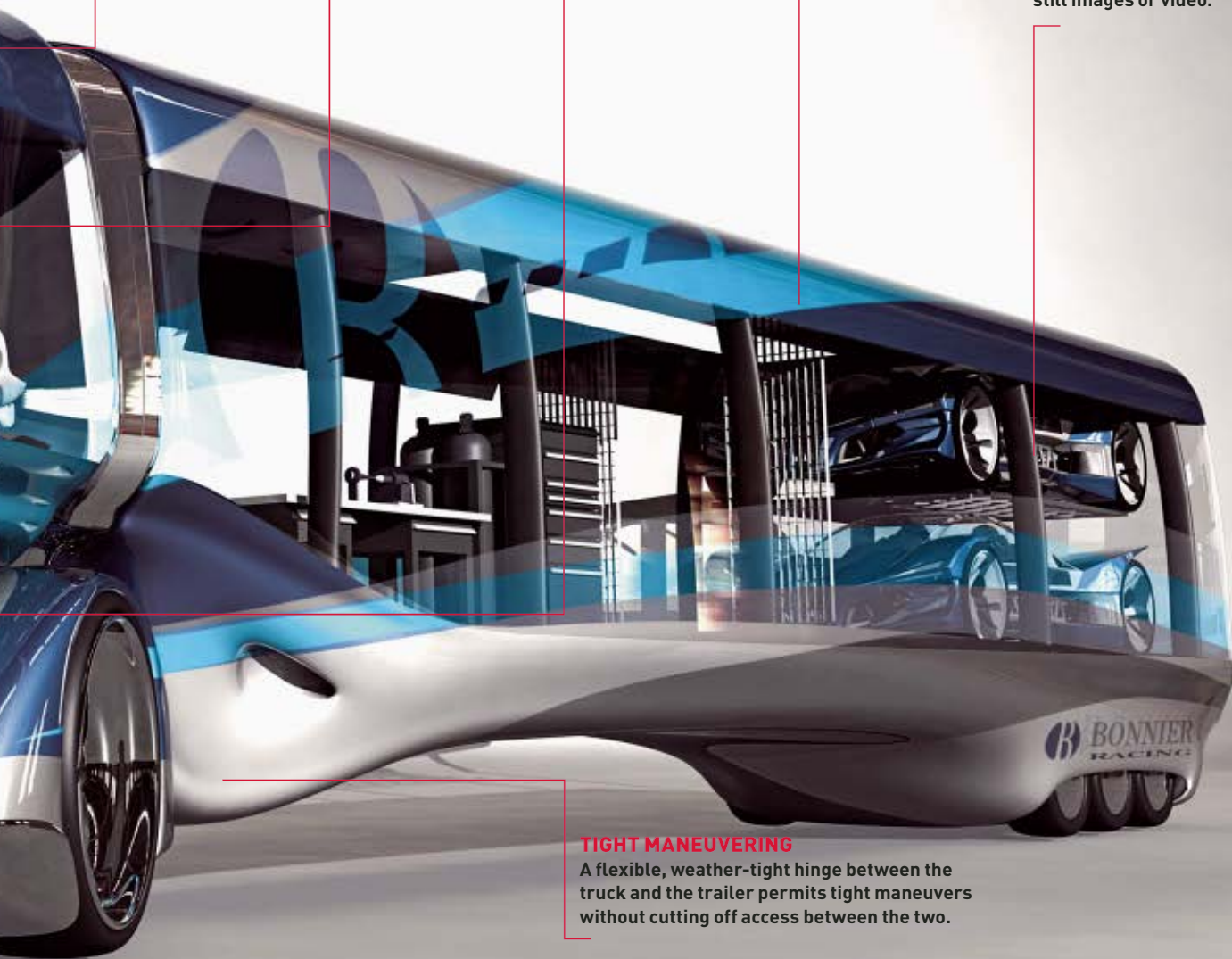
The driver's station connects to the crew deck through a central passageway.

LOW DRAG

Sleek, aerodynamic shaping, ultra-lightweight wheels and composite frame construction minimize weight and drag.

DYNAMIC SHELL

Transparent skin with embedded, digitally controlled OLED panels can let the sunshine in—showing off the team's handiwork to race fans on the road—or keep things dark for privacy. The entire structure can display still images or video.



TIGHT MANEUVERING

A flexible, weather-tight hinge between the truck and the trailer permits tight maneuvers without cutting off access between the two.

THE FOUR CONCEPT VEHICLES presented on these pages are based on interviews with designers and engineers at BMW, Lotus Engineering, Audi Design, Ford, General Motors, Jaguar, Segway, the Academy of Art University's School of Industrial Design and the College for Creative Studies. Research conducted by Eric Adams and Dan Lienert. Design and illustrations by Nick Kaloterakis [Javelin and SNAP!], Bob Sauls/Frassanito [Extender] and Peter Bollinger [Nomad].

Environment



The most fuel-efficient auto company in America*. Meet Small Oil. Honda has always been committed to developing environmentally responsible technology. And with cars like the all-new Fit along with the legendary Civic, Honda will continue as the leader in fuel efficiency.[†] Through innovation and hard work, Small Oil can make a world of difference. That's our Environmentology.[™]

HONDA
The Power of Dreams

environmentology

Honda thinking in action.



*Based on model year 2005 CAFE average fuel-economy ratings and weighted sales for passenger-car and light-truck fleets sold in the U.S. by major manufacturers. †Civic Hybrid and Fit Sport with 5MT shown. 2007 EPA mileage estimates: 49 city/51 highway, 33 city/38 highway, respectively. Use for comparison purposes only. Actual mileage may vary. ©2006 American Honda Motor Co., Inc. environmentology.honda.com

TAKING IT

The Darpa Urban Challenge asks an autonomous vehicle to negotiate city streets, merge with traffic, and generally avoid smash-ups. The winning team will determine how your car drives in the future

BY BOB PARKS PHOTOGRAPHS BY JOHN B. CARNETT



TO THE STREET

THREE KEY FACTS

- 1** The Darpa Urban Challenge tests autonomous, unmanned cars in a grueling obstacle course through a mock city.
- 2** The various strategies range from relying on GPS to using lasers and video cameras to monitor the surroundings.
- 3** Winners' ideas will help direct the field of commercial vehicle robotics, already estimated to be a \$1.9-billion industry.



ROBOT RIVALS The Golem Group's Richard Mason [facing page] believes his vehicle can win the race with minimal sensors and a smart laptop. Keoni Mahelona [above] and his fellow MIT students believe Talos, with its tremendous array of sensors, can see its way to the finish line first.

The 3,500-pound Ford Escape jackrabbits off the start line, throwing us back in our seats as it accelerates toward two orange barrels in the distance. Yoshi Kuwata, a newly minted MIT Ph.D. in the driver's seat, hasn't touched the wheel and isn't looking out the windshield.

Instead he stares intently at a large dash-mounted LCD showing two bright dots on a black background. They're the virtualized barrels in the truck's world. As the dots come into sensor range, the truck slows indecisively. There's a collective holding of breath. Suddenly, it veers away, the steering wheel rotating on its own. Kuwata and Gaston Fiore, a fellow student riding shotgun, smile broadly at each other but try, for my benefit, not to look too relieved.

As the Escape picks up speed, however, it steers toward a rusty outbuilding. The tension in the car rises. In 44 acres of flat concrete at this decommissioned Navy airstrip in Cambridge, Massachusetts, we're headed for the only genuine hazard around. Kuwata eyes the E-stop, a

bright red button near the gearshift that brings the car to a halt. Fiore clicks furiously through electronic views, trying to see the building as the truck does. The sound of the bumper-mounted 3,000-watt gasoline generator feeding juice to the equipment is deafening. This is one

of the first fully autonomous trips the car has ever taken, and even though we're going no more than 20 miles an hour, there's an unnerving quality to the driving, especially because without a human pilot, there are no physical cues to let me know if the driver is paying attention and plans to stop. The truck seems sure for one moment, then weaves. In a light truck, it occurs to me, a head-on collision even at 20 miles an hour can pancake a foot of steel. I try not to panic.

Kuwata and Fiore wait anxiously to see if the software will navigate its way to safety, but they're losing faith—the side of the building is less than 100 yards away, looming dangerously. Suddenly the Escape brakes hard, sending the tape recorder on my lap into the front seat. Kuwata, shaken, presses the red button and grabs the wheel.

"The software still has some bugs," he says quietly.

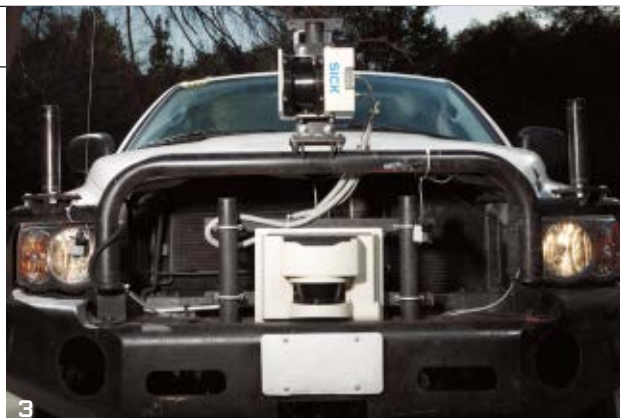
GOLEM

STRATEGY: FOLLOW THE MAP

THE GOLEM GROUP outfitted a Dodge truck to drive using intuition and a map. Its primary navigational trick is to follow its GPS system from one waypoint to the next, rather than constantly analyzing its surroundings. Its sensors are reserved for detecting obstacles, which means a single laptop can handle the code.



DRIVING BY FAITH The hood-mounted antenna [1] pulls down GPS and other navigation signals to produce a "dGPS" fix, a highly accurate multisource reading and Golem's primary means of finding its way. The rooftop laser sensor [2] spins 20 times per second for a 360-degree view of the world, while a 90-degree laser range finder on the hood picks up a vertical slice of the world up to 70 yards away, and a 180-degree lidar on the bumper senses nearby



hazards [3]. The sensor data enters an Ethernet network under the front seat [4], where an inertial measurement unit helps calculate distance. A Lenovo laptop running Linux talks to the car [5], and homebrew interfaces between the computer and the truck's throttle, steering wheel and brake do the driving from the lockbox [6]. The blue motor driver in the center guides the steering wheel, and the black pneumatic driver applies the brakes.

DRIVER'S ED

Bristling with over half a million dollars in sensors and computer processors, this prototype is the Massachusetts Institute of Technology's first-ever entry in the world's greatest contest of driverless cars. The event, scheduled for November in an as-yet-unannounced location, is called the Urban Challenge. It's the third such competition organized by the Defense Advanced Research Projects Agency, or Darpa, the Pentagon's main R&D branch, in an effort to put robot vehicles onto the battlefield. The first Darpa Challenge, a desert race in 2004, resulted in wrecked cars and a list of runners-up; no one finished the race. The next year, a similar course saw four finishers in under the 10-hour limit: a vehicle from a Stanford University-led team, two from Carnegie Mellon University, and one from Team Gray, a private consortium of engineering buddies.

Now, two years later, the race is much harder. Up to 20 competitors will traverse a mock city, merging at traffic circles, passing disabled vehicles, avoiding cinder blocks in the street—driving scenarios that can daunt even humans. A series of qualifying events ends in a race to finish a final course in the shortest time. The largest field of teams yet—universities, military contractors, groups of friends—is sharpening swords all over the country, sprinting to build an entry in time. With top speeds of 30 mph, the teams will risk everything from fender-benders to 'bot-wrecking head-on collisions with one another. "The perceptual difficulty is huge," says Mike Montemerlo, the software leader for returning champion Stanford. "The hazards in this race could hit you from anywhere."

The stakes are equally huge. The top three finishers receive \$2 million, \$1 million and \$500,000, respectively,

and an elite group of 11 "Track A" teams, MIT among them, have received heavy-duty additional development money directly from Darpa based on the merits of their written proposals. But more important, with the greatest minds and deepest pockets of the robotics world watching the competition, the teams that perform well will be the pioneers of unmanned driving. These awkward, overladen vehicles are competing to be the great-grandparents of the cars that will someday drive us home from work on autopilot.

START YOUR ENGINES

When the Stanford team won two years ago, the victory sent a message: Robotic autonomy requires great code and powerful computing. Everyone in the robotics community knows the story. Three coders—Montemerlo, David Stavens and Hendrik Dahlkamp—



TALOS

STRATEGY: WATCH THE ROAD

THE MIT TEAM has poured time and resources into a wide variety of sensors and the computing power necessary to constantly decipher the resulting data. Unlike Golem, Talos relies on its GPS system only to make broad navigational decisions. Its lasers, radar and video cameras do the real work.

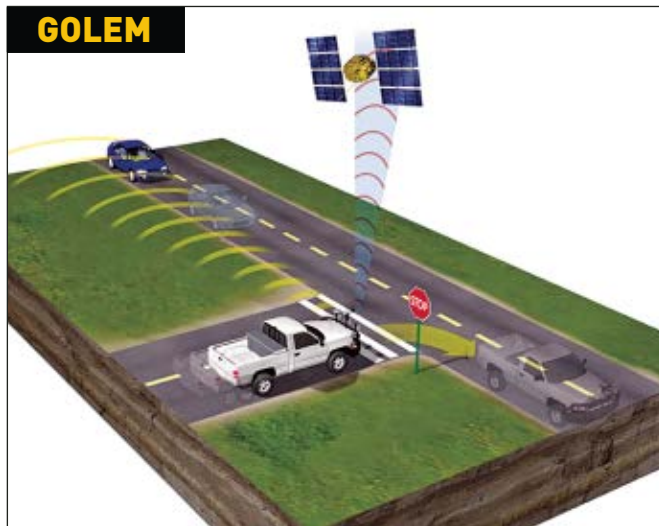
EYES ON THE ROAD Three rooftop "push broom" lasers scan the road 75 times a second [1] and can detect objects at 50 yards to within a quarter of an inch. Three "skirt" lasers on the front bumper detect stationary obstacles. Above the windshield and on the hood are three radar sensors that can spot objects up to half a mile away, and video cameras all over the truck [2] help pick out painted road lines and identify other bots by color.

The flood of data, displayed to human testers on monitors in the front seat [3], is crunched by a supercomputer containing 40 separate one-gigahertz processors [4]. The computer will eventually suck four kilowatts, the equivalent of two large suburban homes. A 3,000-watt generator [5] powers all the gear, but by race day, the power source will have to be inside—the team expects to fit the engine with a 4,000-watt alternator.

HOW TO MERGE LIKE A ROBOT

THE GOLEM GROUP NAVIGATES primarily by GPS, steering from one waypoint to another, and uses only a few sensors and assumptions to react to unmapped obstacles. Talos favors state-of-the-art sensors and heavy-duty computers, getting a full picture of the surrounding world and forming moment-by-moment decisions based on perception. Here's how each vehicle would merge at the same T-junction.

GOLEM



1. Golem knows where to stop by laying GPS coordinates and data from an inertial sensor on a digital map given out by Darpa. It infers the path other vehicles should follow as they approach the same intersection.

2. It needs to recognize a car doing 30 mph at least 200 feet (five seconds) away to have time to turn, accelerate, and still maintain the Darpa-mandated separation distance of three vehicle lengths.

3. Using its laser sensors, the truck scans for blips in appropriate places on the mapped environment. If it registers a blip, it waits. If after several scans no blip approaches, the truck accelerates.

TALOS



1. Using its video cameras, Talos stops at an intersection by identifying the white stop-line in the roadway and analyzes the roadway to its left using radar. Software generates hypotheses about every object it sees.

2. Talos "bets" on whether an approaching object is a real car or just sensor noise. Real car? Talos establishes the speed, direction and acceleration of the vehicle and tries to predict its intentions.

3. If there's enough time to turn, it analyzes and models the street corner with laser sensors, plots several optional ways to take the turn, and chooses the most efficient and graceful path.

stationed themselves at a bar in the Mojave Desert called the Slash X Ranch for nearly six months, pounding out code at night over beers and testing the vehicle on a desert track each morning. By August, just four months before the deadline, they decamped to a suite of hotel rooms near Phoenix, worked from 8 a.m. to midnight, and finished coding in time to beat the heavily favored Carnegie Mellon. Since then, Stanford has moved from six Pentium processors to 10 Intel QuadCore processors, a roughly four-fold jump in bit-pushing power.

A small group of MIT graduate students—Edwin Olson, Albert Huang and David Moore—watched Stanford's win in 2005 and begged their professors to make a run at this year's race. Like a football

team scrutinizing its rivals, the group studied hours of Darpa Challenge footage. "We saw a lot of jittery moves and over-compensation," Olson says. The group named their vehicle Talos, after an avenging bronze robot in Greek myth. By early last June, Huang had reverse-engineered one of two main Stanford algorithms. By November, Olson had devised code that neatly limned the road in yellow and delineated the car's view for hundreds of feet. More recently, he added a view that spots oncoming cars and superimposes tiny vector lines to show their direction. Talos grows more sophisticated every day.

CONFIDENCE AT THE WHEEL

The race is, in the end, about teaching a car to make decisions in the face of

uncertainty. The MIT team calls it "uncertainty estimation." Stanford uses the more take-charge term "probabilistic robotics," pioneered by team leader (and PopSci "Brilliant 10" honoree) Sebastian Thrun, who led the school's 2005 championship run. You've experienced what they're studying. Behind the wheel, you're in the thrall of uncertainty when you wonder if that waiting car is going to pull out in front of you. Uncertainty is having to decide whether to pass a car in spite of oncoming traffic. It's having a blinding ray of afternoon sun in your eyes, hoping to God you don't hit anyone in the next few yards. They're all nerve-wracking moments for human judgment. The difficulty of teaching a computer to



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*Actual mileage may vary depending upon driver ability, vehicle type, and the type of driving and road conditions.
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STANFORD'S BABY Urban driving is tough. At press time, returning-champion Stanford's entry, a Passat dubbed Junior, was still struggling to see stopped cars and concrete islands.

sort them out will be enormous.

"MIT has leaders in the area of perception, so they certainly have the talent to win it," says Wes Huang, a senior research scientist at Applied Perception, a company born of Carnegie Mellon's Robotics Institute, and last year's co-chair of the prestigious WAIR robotics conference. But it will be a sprint over the next nine months to tame MIT's code into something that doesn't blindly plow into metal buildings and that drives better than Stanford, Carnegie Mellon and dozens of other public and privately funded teams do.

Back in the MIT team's garage at Olin College, an MIT partner and undergraduate engineering school, Kuwata guides Talos into its temperature-controlled bay. Students here spend 40 hours a week on Talos beyond their regular studies, and as we park, they close in like surgeons shoulder-to-shoulder in the same operating theater. There are more Ph.D.s in the room than places to sit. Olin prof Dave Barrett, the former vice president of engineering for Roomba maker iRobot, is in charge of electronic and mechanical systems. A tall guy in wire-rimmed glasses, jeans

and a natty flannel shirt, Barrett leaps nimbly onto the truck to secure a wire. Having him as head mechanic is like hiring Dale Earnhardt, Jr., as a chauffeur.

The vehicle is overloaded with more gear than a family SUV headed for a beach weekend (though jaded Boston drivers don't give it a second look when it's driven through town, Barrett tells me). Ten lasers—five on the roof, five on the bumpers—scan the road ahead of the truck 75 times a second. Radar and video cameras round out Talos's senses. The data goes through PVC cable conduits in the roof to the high-powered computers inside. It's hard to imagine autonomous driving without all this equipment. But another team in this competition thinks MIT, like Stanford, has it all wrong.

THE MILLION-DOLLAR UPSTART

Although MIT and Stanford, the most visible competitors, are passionate rivals, their strategies for the Urban Challenge are fairly similar when contrasted with the Golem Group. The Golem team is one of the only independent players in Track A—it's not part of the government or a university—and its approach makes it a wild card. Led by Richard Mason, a mechanical engineer for the think tank RAND Corporation and an expert on path planning for robots, the team has designed a vehicle that has only three lasers and, incredibly, a single laptop controlling it.

Mason began work on Golem (the name comes from a score-settling automaton in 17th-century Jewish legend) four years ago to compete in the first Grand Challenge, just after getting his doctorate from the California Institute of Technology. His research there showed how to guide a ground robot over long distances using small, discrete nudges instead of long-term plans. Back then, Golem was a garage start-up, with an all-volunteer staff and a Ford F-150 truck that Mason bought with \$35,000 in winnings from the game show *Jeopardy*. A single laptop was as much processor as the team could afford, but it was more than adequate: Golem came in an amazing fourth in 2004 and 14th in 2005. It's earned the

YOUR LAZY FUTURE

Intelligent cruise control and self-parking are the robot tech of today. You'll barely drive the vehicles of tomorrow

TECH	FUNCTION	LIKELY DEBUT
Lane-departure correction	Cameras watch road lines; sensors monitor motion and steering. If algorithms judge unintentional veering, the car brakes.	2010 (current research by Nissan)
Smart adaptive cruise control	Car makes assumptions based on GPS awareness of road features and other cars' taillights to detect sharp corners.	2015 (current research by Jaguar)
Networked collision avoidance	Moments before an impending collision, cars exchange vector and velocity information to coordinate a safe swerve.	2025 (current research by DaimlerChrysler)
Robot-chauffeur mode	The car drops you at the airport and proceeds to a robots-only garage. After your trip, a text message brings it back.	2030 (current research by Volkswagen)

COURTESY STANFORD UNIVERSITY RACING TEAM

government's Track A funding this year with a pledge to keep it simple. The team has put months into teaching a Toyota Prius, christened Golem 3, to drive intuitively based on what it knows of its location on the GPS map provided by Darpa a few hours before the race. "Everyone boasts about needing a ton of computers," Mason says. "We try to see what we can do with one computer making good assumptions."

But the Prius won't be running the race. One evening in January, lead programmer Jim Radford drove it from one teammate's garage to another, creeping along in the slow lane. Another driver suddenly tried to pull into a gas station from the center lane, and the Prius's shot at glory was over.

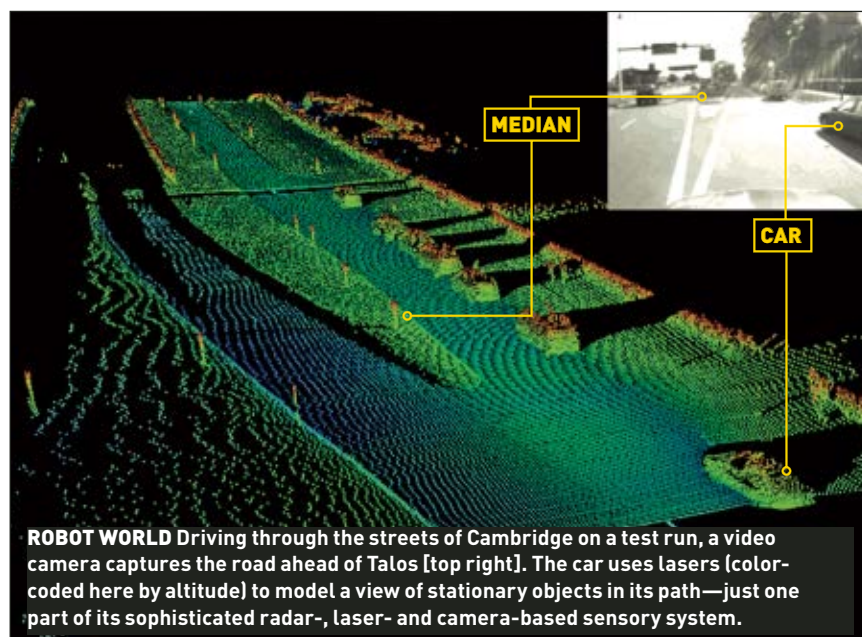
The irony of human error wrecking his creation isn't lost on Mason. "Maybe if the other car had been autonomous, and had some spinning 360-degree sensor," he says with a tight smile, "it would have spotted us." But the team is plugging on, spending the Darpa stipend to outfit a Dodge Ram 2500 with systems intended for the wrecked Prius.

Mason says the team's "gum and paper clips" style helps pare problems—and solutions—down to their essential elements. Even though the laser range finders, for instance, are rated to work at only 50 yards, they can get good, useable data at over 80, so Golem's lasers are tuned for maximum distance. And because the car isn't dealing with a deluge of sensory data, one measly laptop will be sufficient. The lean approach will ultimately pay off, Mason expects, when developing real-world military or civilian applications. "If you can achieve the same goals with low-cost equipment," he says, "then that's a flat-out better commercial solution." And when it comes to the Urban Challenge, "sensors aren't going to dictate who wins. This is all about planning."

SIGHT VS. NAVIGATION

The line between perception (what's nearby the car) and planning (what to do about it) is what distinguishes MIT and Stanford's programs from Golem's [see "How to Merge Like a Robot," page 62]. Both considerations come into play in any autonomous vehicle, but

HOW TALOS SEES THE ROAD



MIT and Stanford focus on the former, Golem on the latter. MIT devoted more than half its working hours and 80 percent of its computing power to perception, and it recently added radar to the sophisticated composite eye of lasers and video cameras atop Talos. Stanford just rounded out its own costly laser array with another new \$75,000 laser sensor. The thinking goes that if you can identify things accurately on the street, the job of deciding what to do will be a whole lot easier. Golem, in contrast, plans to use only a few sensors and to rely instead on GPS and sophisticated programming to make the right on-road decisions.

Seeing is a combination of sensing what's out there and organizing that visual world into meaningful objects and behaviors. But there are perceptual limits for robots just as there are for humans. Did you ever spot what looked like a potentially dangerous obstacle ahead on the highway, only to have it turn out to be a ratty old plastic bag blowing around? Without the judgment learned after years of driving, robots have an even harder time with perceptual ambiguities. For example, the MIT car has yet to show that it can reliably filter out nearby

obstacles from tall grasses swaying far in the distance. Over in Palo Alto, California, Stanford's Thrun has been wrestling with a handful of persistent flaws in his own recalcitrant car. Despite having already logged 100 miles of autonomous driving, "Junior," an autonomous Volkswagen Passat, can't reliably see other cars. It consistently misidentifies a concrete island on the test track as a stalled SUV, grows skittish, and screeches to a halt. And worse, once moving cars come to a full stop in front of Junior, it suddenly seems unaware that they exist.

To overcome these types of perception problems, MIT and Stanford will teach their cars to factor in uncertainty using a statistical approach. In MIT's code, the computer generates dozens of hypotheses about the current situation and graphs them according to likelihood—a sort of mathematical moment of introspection. The computer then picks the winning hypothesis from the most consistent suppositions. "It gives us a sense not only of where we think things are, but how unsure we are about it," Olson explains. Just as Mason thinks his creation will be able to plan its way to first place, both MIT and Stanford believe that building

THE UNDERDOGS

The gutsy, scrounged 'bots of the Track B teams are no joke



TEAM GRAY In 2005 this Louisiana-based group's 'bot was one of only four to finish, and one Darpa official called its driving "nearly flawless." Yet the team's proposal didn't make the Team A cut this year. "My guys weren't upset long," says co-leader Eric Gray. "They like being the underdogs."



A BUNCH OF DROPOUTS Other teams are easier to peg "Track B." Kevin Jackson, a digital-imaging exec and head of this eccentric Arizona team, spent \$250,000 to test his biology-based artificial-intelligence theories in a 1941 military ambulance fitted with four dual-core 64-bit processors.



TRUE VISION ROBOTICS By observing his blind cat, Steve Isakson of Atascadero, California, says he discovered a method for intuitive navigation. He'll use video cameras, GPS and computers fitted to a rusty 1984 Mercury Topaz that looks like it couldn't take a bump from another car.

smart, skeptical eyes—vision coupled with self-doubt—will win the race.

A MATTER OF STYLE

The choice between a perception-heavy strategy and a planning-heavy one imbues each team's vehicle with a particular driving style. When Stanford and Golem's vehicles covered the same qualifying course during the 2005 Grand Challenge, the difference between the driving was remarkable. Stanford's SUV started its turns well before obstacles. Its driving was certain and elegant, like a steel-nerved chauffeur. The only indication that a robot was at the wheel was the way the Stanford vehicle didn't slow, even a little, as it steered through a narrow slit formed by two pieces of corrugated steel. Human drivers hesitate slightly to give themselves more time to think. A computer doesn't need time. Stanford's 'bot proceeded at a moderate, measured pace, and during the qualification week, it completed the same two-mile course twice in exactly the same amount of time.

Golem's F-150 accelerated along the straightaways like a guy pissed off after a fight with his girlfriend. At one point, the truck roared from 0 to 40 in eight seconds. It pulled up behind a junk car in the way, paused there impatiently, and gunned to one side. "The car accelerates fast and may jerk hard in one direction if it sees an obstacle," Mason admits. "Your typical human commuter makes more subtle moves, sure, but that's just gravy."

MIT expects that Talos will drive much like Stanford's Junior, both because of the underlying technology and because both teams want a smooth style. "Darpa told us we should exhibit human-like driving," says Ed Olson of MIT. "So we're going to model it on a cautious driver. But you know, we could safely maneuver in a way that would scare the hell out of anyone."

CHOOSE YOUR FUTURE

Someday we'll probably be sharing the road with the likes of Talos, Golem and Junior. Innovations from the successful Darpa teams will probably first show up as modest improvements to

assistive-driving technologies already on the market. But someday, rather than improving the skills of the human driver, the new systems will be able to take over whole chunks of the task.

According to Jacob Peters at the University of California at Davis Institute of Transportation Studies, American highways are full of wasted space, with vehicles occupying only 8 percent of the available road. Active safety technology that makes cars drive closer together would easily double capacity. Autonomous systems would also save energy, as Seth Teller, an MIT faculty adviser and Talos's perception guru, points out: "If cars are communicating, no one has to idle at a light for three minutes again." The human style of driving—hesitation, merging early, absent-mindedly waving other drivers ahead into danger—is inefficient and, as accident statistics show, unsafe. It seems that the real advantages of automated cars will be realized by odd-looking, robotic driving, not by cars that simulate human habits. No human passenger would stand for it, but Golem's herky-jerky driving style may be the clearest expression of the future after all.

That said, the very robot-ness of Talos still provokes my human paranoia. Looking up at the windshield, I try to imagine what it will be like to traverse a crosswalk in front of it. No reassuring eye contact (*See me? OK, I'm crossing now*), no friendly wave. I suddenly remember watching a large truck in Darpa's 2005 event that careened through a metal barrier and roared cheerfully out of sight. In spite of all the improvements Talos will probably undergo between now and race day, for now this beast is still something to be cautious around.

While surveying the vehicle for the last time, I notice that someone on the MIT team has drilled eight holes in its body and neatly mounted large red buttons marked "STOP" on the hood, side panels and trunk. I ask Dave Barrett about them. "This is a 200-horsepower autonomous vehicle," he replies, eyeing the car warily. "You want this thing to jump to life?"

Bob Parks is author of the book Makers.

FROM TOP: COURTESY TEAM GRAY; COURTESY KEVIN JACKSON/JACKSON DIGITAL IMAGING; COURTESY STEVE ISAKSON



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THREE KEY FACTS

- 1** The Tesla Roadster, JB Straubel's all-electric supercar, can **out-accelerate a Lamborghini Gallardo** and still travel 250 miles before it needs to recharge.
- 2** It's powered by **6,831 lithium-ion batteries**, commonly used in laptops.
- 3** Tesla plans to **produce up to 2,000 Roadsters next year**. The 100 to be made this year went for \$100,000 each.

CAN 6,831 LAPTOP BATTERIES CHANGE THE WORLD?

JB Straubel has created the world's fastest electric sports car, the first step in making fun and eco-friendliness truly compatible concepts. Can the rest of the car world catch up?

BY PRESTON LERNER
PHOTOGRAPHS BY JOHN B. CARNETT



SUPERCHARGED Tesla Motors engineer JB Straubel with the Tesla Roadster. The car's battery pack contains thousands of lithium-ion cells adapted from laptop computers.

IT WAS LIKE FRANKENSTEIN, only faster. JB Straubel, in 1999 an emerging superstar in Stanford University's school of engineering, had been haunting the student machine shop, fabricating parts for his '84 Porsche 944 from midnight until 4 in the morning. Working by trial and error, he developed his own power controller and charger. He mated together two electric motors

with a homemade coupler and belt system. He gutted the car and crammed in 840 pounds' worth of lead-acid batteries. Start to finish, the project took him a year.

By early 2000, Straubel had taken a piece of once-state-of-the-art German engineering and transmogrified it into a pretty advanced science-fair project: The World's Fastest Electric Car. Or so he hoped. With 180 kilowatts at his disposal (about 240 horsepower), the car had enough power, he estimated, to set an electric-vehicle world record for the quarter mile. Just one problem: Total range was 20 miles. What good is it, he figured, to build an all-electric emission-free dragster, if you're just going to tow it to the race-track on the back of a big truck?

And so Straubel set about doing what any driven, somewhat obsessive-compulsive engineering graduate student would do. He bought a Volkswagen Beetle for \$500, chopped it in two with a shop saw, and used a trailer hitch to

attach the back half—the part with the engine and driven wheels—to the rear of the Porsche. He ran a remote throttle and ignition from the VW to the Porsche's driver's seat. From there, he sat and steered while his mongrelized single-axle trailer *pushed* the 944 down the road.

"I drove it 800 miles to Oregon," Straubel says. The problem was not the obvious potential for jackknifing. Rather, it was that while he was up ahead in the Porsche, the clutch and stick shift were back in the VW. "I'd leave it in third or fourth gear and start off under the Porsche's power," he recalls. "The VW would lug and make all these terrible noises until I got up to speed. Then I'd turn on the ignition, and it would start running and pushing the Porsche. That was a hell of a trip."

The Porsche did eventually break the world record for the electric-vehicle quarter mile—17.278 seconds at 79.14 mph, set at Silent Thunder 2000, a National Electric Drag Racing event in Sacramento, California. Today Straubel

INSPIRED DESIGN Tesla built the Roadster on a modified Lotus Elise frame, and Lotus will build the Tesla on its assembly line.



finds that time embarrassing. His latest all-electric creation is faster off the line than a 510-horsepower Lamborghini Gallardo. More important, it can run 250 miles between charges, not 20, in large part because it's powered by laptop batteries. And beginning later this year, anyone with \$100,000 can buy one straight off the assembly line.

Straubel has proven that he can build an electric car that's as good as

A CONDUCTIVE EDUCATION

Before Tesla, there was the Porsche. And the moped. And the crazy trailer



Straubel transformed a 1984 Porsche 944 into an electric car by installing two DC motors powered by 20 12-volt batteries

weighing 850 pounds. Because the car had only a 20-mile range, he cut a Volkswagen Beetle in half and rigged it to push

the car to racing events. On its own, the Porsche could accelerate to 60 mph in 8.7 seconds and reach a top speed of 104 mph.



In 1998, Straubel built an electric bicycle with a 10- to 25-mile range and a top speed of 32 mph. He used two lead-acid batteries and a motor mounted under the frame. The 60-pound bicycle ran by pedal power, the electric motor, or a combination of both.

FROM TOP: JOHN B. CARNETT; COURTESY JB STRAUBEL (2)

THE CAR'S SEXINESS IS ITS BEST CHANCE OF SURVIVAL.



gas—one that doesn't sacrifice power, range or speed. But does that mean the Tesla Roadster heralds a new era of electric vehicles on every street corner, as he believes? Or will the Tesla, impressive as it is, be remembered as just another electric-vehicle science-fair project?

STARTING IT UP

Straubel was among the first hires at Tesla Motors, the San Carlos, California, startup that's building the Roadster. The 31-year-old's title is chief technical officer, though with his healthy mop-top, he looks ridiculously young for the job. His challenge is to create a practical electric car that's also a thrill to drive. Convincing the world (and the venture capitalists in the world) that the company isn't nuts for trying, that falls to Martin Eberhard and Marc Tarpenning, the two former Silicon Valley engineers who created Tesla in 2003.

Straubel's two bosses had just sold their pioneering electronic-book-reader technology in 2000 and were eager to do something that could help amend the world's environmental problems. Their idea: an electric car that people would *want* to own and that didn't have

the limited range of previous electrics. The explosion of the portable-electronics industry had created a huge market for efficient, lightweight lithium-ion batteries. All they had to do was exploit the economies of scale and use these laptop batteries to power an electric car. Their strategy was to make it irresistibly fun, not the sort of painfully dull electric vehicle—what Eberhard calls a “punishment car”—that would only be driven by those who saw cars as a necessary evil. Once they demonstrated their success in a low-volume “halo” car, they would move on to build electric sedans.

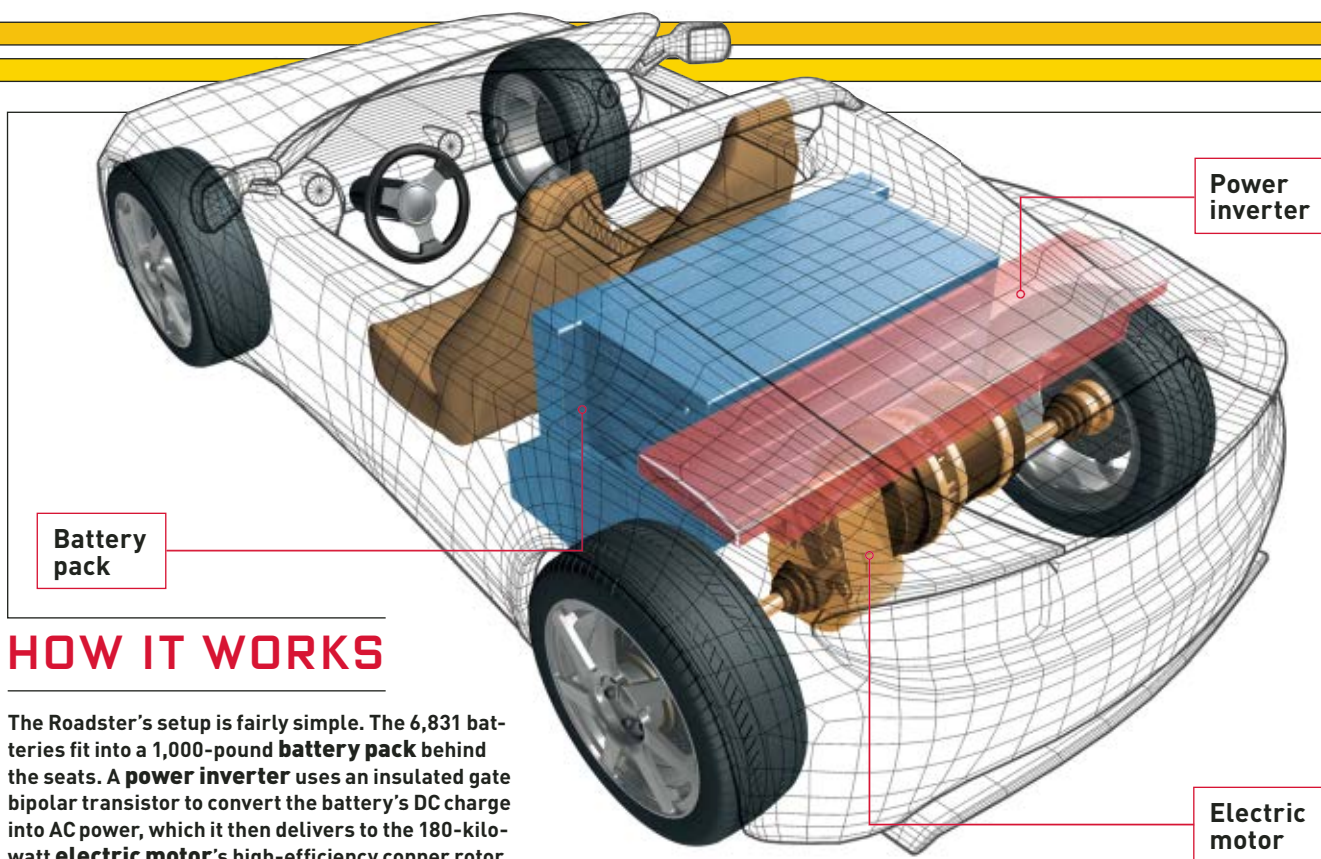
When Tarpenning and Eberhard incorporated Tesla in 2003, they needed two things: First, an engineer who could make the plan work. Second, an angel to pay for the substantial R&D that lay ahead. The two of them started trolling Sand Hill Road, cold-calling Silicon Valley venture capitalists. Most of their pitches netted zilch. Although the idea of powering a car with lithium-ion batteries didn't make the investors hugely nervous, the dismal track record of most efforts to launch new car companies made them leery.

And then they talked to Elon Musk.

Even among Bay Area pioneers, Musk is a bit of a risk-taker. He had sold PayPal, the company he co-founded, to eBay for \$1.5 billion in 2002 and promptly started SpaceX, a venture that would design, build, and launch rockets to serve what he foresees will be a growing demand for low-cost access to space. The company is one of two that won contracts—SpaceX's share was \$278-million—from NASA last August to design a small crew and cargo launch vehicle to supplement the next space-shuttle replacement.

Here on Earth, Musk has an abiding interest in alternative energy. To date, he's provided about \$27 million of the \$60 million raised by the Tesla. “I'm hoping it can become one of the major car companies of the 21st century,” he says. “It's got a great opportunity to change the world.”

So that left the matter of finding a lead engineer. The challenge here, they found, was that electric-vehicle experts, though ever enthusiastic, weren't necessarily great engineers. “JB's name came up during a Google search,” Eberhard recalls, “but I wasn't sure if he was wacko or not.”



HOW IT WORKS

The Roadster's setup is fairly simple. The 6,831 batteries fit into a 1,000-pound **battery pack** behind the seats. A **power inverter** uses an insulated gate bipolar transistor to convert the battery's DC charge into AC power, which it then delivers to the 180-kilo-watt **electric motor's** high-efficiency copper rotor.

Straubel was already working on an electric-vehicle project of his own, partnering with a team of Stanford students to build an electric car—never completed—that would go up to 3,000 miles on 10,000 laptop batteries charged once, and he lived less than a mile from the small, second-story office that Tesla was working out of. He met with Tarpenning and Eberhard and enthusiastically agreed that the future of electric vehicles was going to be built from lithium-ion batteries. Straubel mentioned that he'd once approached their backer, Musk, about funding an experimental aerospace project. Eberhard phoned Musk, who was on Straubel's list of references, after the meeting.

"What do you think of this guy JB Straubel?" Eberhard asked. Musk replied, "I was thinking of offering him a job at SpaceX." Tarpenning and Eberhard got to him first.

A HUNGER FOR POWER

Good engineers solve big problems with complex solutions you could never understand. Great engineers apply such simple solutions that you

can't believe you didn't figure them out yourself. Witness Straubel's work on the unmanned, hydrogen-powered, high-altitude, ultra-long-endurance airplane that he developed for the communications industry. This was in 2001, two years out of Stanford, when he collaborated with Harold Rosen, an engineer 50 years his senior best known for inventing the geosynchronous satellite. The airplane had to loiter within a very small slice of airspace to efficiently relay messages. The engine had to run at a constant speed to maximize efficiency. But to stay in one place in variable wind conditions, the airplane's speed had to change all the time.

How to alter airspeed without changing engine power? Straubel's solution was to adjust the altitude. Ascend to slow down, descend to speed up. "It was a very simple, yet very elegant, solution," says Rosen, a member of the National Inventors Hall of Fame who speaks of Straubel with almost paternal affection. "He was sensational."

Growing up in Wisconsin, Straubel played with Legos and chemistry sets. When he was 12, he brought a long-dead

ROAD TEST



Starting the Tesla Roadster is as exciting as blinking my eyes. There's no noise, no vibration, virtually no sign of life. Then, the acceleration pins me to my seat, with all 200 pound-feet of torque available from 0 to 8,000 rpm. The lack of engine and exhaust noise seems to violate the laws of physics, like doing a burnout without generating any smoke.

The Tesla retains the fully independent suspension of the Lotus Elise and handles exquisitely. I'm struck more by the similarities than by the differences between it and conventional sports cars. It's this very normalcy that makes the Roadster a breakthrough. It will be expensive—you can buy some amazing cars for \$100,000—and the batteries take 3.5 hours to charge, but those are the only compromises Tesla owners will make.—P.L.



CREATURE COMFORTS Tesla's prototype includes leather seats and a performance steering wheel [top left]. Instruments include readouts on battery charge and your quickest acceleration of the day. LED taillights and high-intensity discharge headlamps [above and bottom left] and other details are styled differently from the Lotus. A two-speed transmission [left] is all that's required, given the electric motor's high torque. There's no dedicated reverse gear, since the motor can simply run backward.

golf cart back to life as his first car. His idea of fun was visiting power plants and cement factories, the seeds of a life-long interest in energy. "It's what defines our entire society," he says. "It's unseen, but it's what allows the room to be hot, the lights to be on, food to be cooked."

Straubel gets his residential power from second-hand photovoltaic solar panels that he personally repaired and installed on his roof, but don't mistake his work for activism. "Compared to many of my friends, I'm not an incredibly committed environmentalist," he says. Instead, he thinks environmentalism is a natural by-product of smart engineering. "The common thread running through everything I've done is sustainability. If you engineer something correctly, it won't wreck the environment. I believe we can find ways to do everything we do today—and more—in ways that are more benign."

But he's also been involved in enough failed alternative-energy projects to understand the bottom line, and that's where the Roadster faces another obstacle. "Tesla can't just give cars away," he says. "Any-

body can build a million-dollar car and sell it to somebody for \$50,000. The real challenge is getting consumers to pay you your cost and more."

THE BATTERY PROBLEM

During the early days of the Roadster project, Straubel hosted endless gatherings of Tesla's young engineers around the pool in his backyard. To the neighbors, it sounded like the Fourth of July—a symphony of small explosions. But these weren't drunken bacchanals. The engineers were burning, blowing up, and sledgehammering lithium-ion battery cells to determine exactly what ramifications Murphy's Law held for the Roadster. All over Straubel's yard, you can still see the scorch marks left from these crude failure-analysis experiments.

The success or failure of the company rests on the durability of these battery cells. Electricity is cheap, powerful and plentiful, but designing a car to run on it is anything but easy, as many owners of long-forgotten, failed electric-car companies could well attest. Limited range has always been their major cause of failure.

The General Motors EV1 was infamously yanked off the market in 2001 after only five years. It wasn't sabotaged by cynical automakers or greedy oil companies. What killed the electric car were anemic batteries (though GM's heavy-handed repossession of EV1s from their loving owners did not help to clarify the situation). First lead-acid and then nickel-metal hydride kept the heralded EV1 from going more than 100 miles on a full charge.

Lithium-ion batteries, introduced commercially in the 1990s, seemed to offer a solution. They can hold about double the charge per pound of anything that had come before. But the most common lithium-ion battery on the market—its name, 18650, is based on its measurements of 18 millimeters wide and 65 millimeters long—is designed for consumer electronics. It takes nearly 7,000 of them to power a sports car.

And that, of course, creates other problems. What if one of the batteries caught fire? (The danger of this was highlighted by last year's small epidemic of exploding laptop batteries.) A

(CONTINUED ON PAGE 104)

**THE DISTANCE BETWEEN SOMEDAY AND TODAY
JUST GOT CLOSER.**



CHEVY VOLT™ CONCEPT At Chevy, we're building a road to the future of driving. Our ride starts with ideas like the will put real drivers behind the wheel of our Equinox® Fuel Cell vehicles* And it hits the road in gasoline-reducing technologies over 1.5 million E85 FlexFuel vehicles on the road†), and the eight Chevy models that get at least 30 MPG hwy. with gasoline.**



Concept vehicle shown. Not available for sale.

E-Flex Propulsion System on our Volt concept. It gets tested in programs like Project Driveway, which like the hybrid system on our Tahoe® Hybrid SUV (coming fall 2007), our E85 FlexFuel fleet (Chevy has There's a lot of exciting change just around the corner. See how we're taking the turn at chevy.com



*Vehicle not for sale. †Based on 2007 EPA Fuel Economy Guide. Go to livegreengyellow.com to see if there is an E85 fuel station near you. **Based on EPA estimates and segmentation. Chevy is a trademark of the GM Corp. ©2007 GM Corp. Buckle up, America!

GREEN-FUEL GUIDE

We handicap the future of the key technologies that, little by little, will replace gasoline

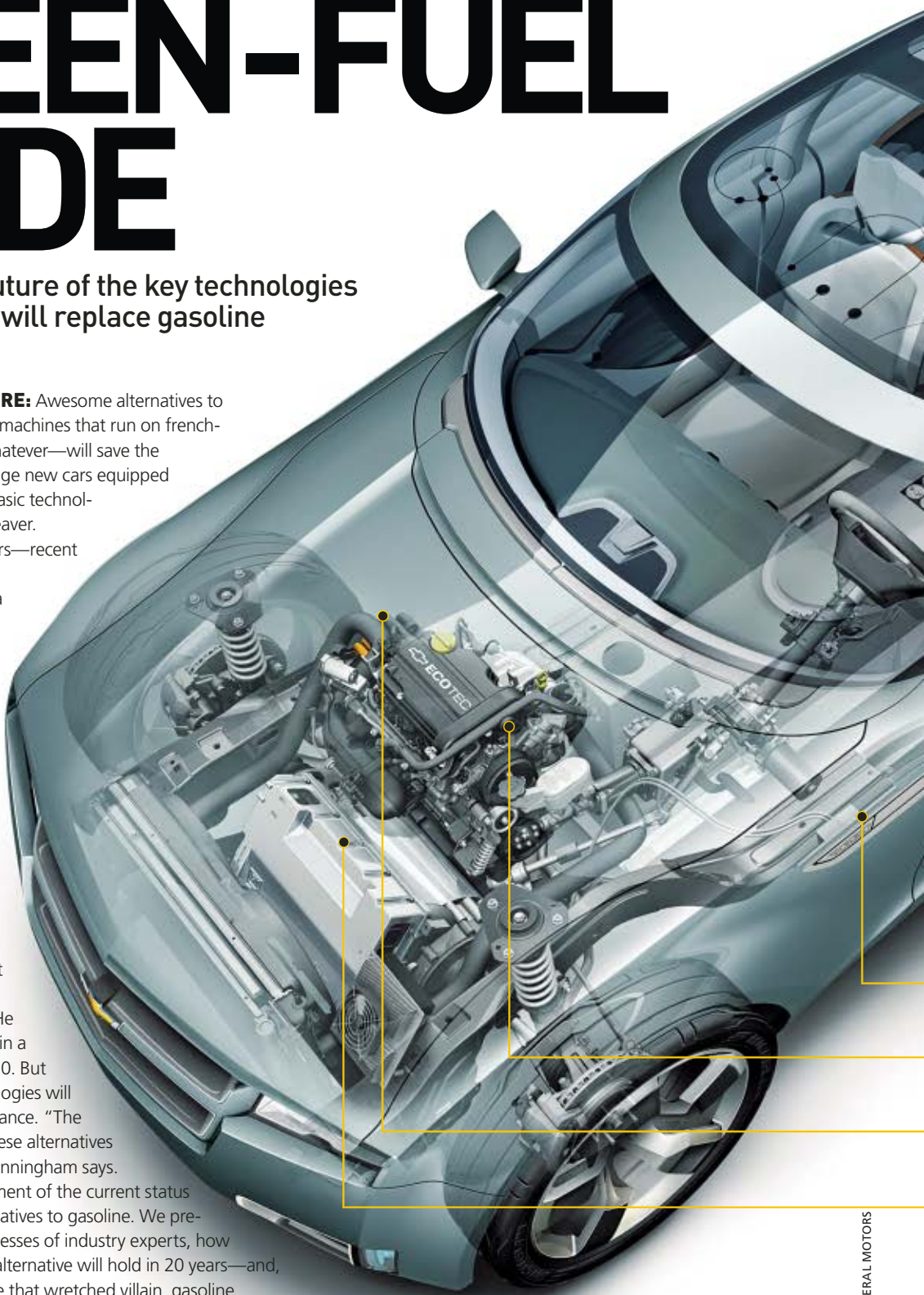
BY LAWRENCE ULRICH

WE'VE HEARD IT ALL BEFORE: Awesome alternatives to gasoline-powered cars—clean machines that run on french-fry grease, recycled diapers, whatever—will save the planet. Yet we're still buying huge new cars equipped with gasoline engines whose basic technology wouldn't impress Ward Cleaver.

But a convergence of factors—recent innovations, consumers fed up with high gasoline prices, and a now-obvious environmental crisis—may finally be creating a tipping point. Auto manufacturers are pushing hybrid, diesel, natural gas, electric and other systems through R&D programs as fast as they can. But there won't be a single-point solution. "There's no silver bullet to deal with the challenges of climate change and energy security," says Joshua Cunningham, a program manager at the University of California at Davis's Sustainable Transportation Energy Pathways project. He predicts that gasoline will remain a dominant fuel until at least 2050. But over that time, multiple technologies will slowly chip away at that dominance. "The only question is how quickly these alternatives are going to enter the mix," Cunningham says.

What follows is our assessment of the current status and the future of the key alternatives to gasoline. We predict, based on the educated guesses of industry experts, how much of the U.S. market each alternative will hold in 20 years—and, as a result, where that will leave that wretched villain, gasoline.

NOTE: Our predicted market shares—which will be affected by technology developments, energy policy, consumer demand and international politics—result in gasoline-only vehicles retaining 35 percent of the U.S. market in 2027.



COURTESY GENERAL MOTORS

BATTERIES

PROS: CLEAN ENERGY, HIGH MPG
CON: NOT POWERFUL ENOUGH

Whether in hybrid form or alone, electric propulsion will lead the way out of the petroleum era

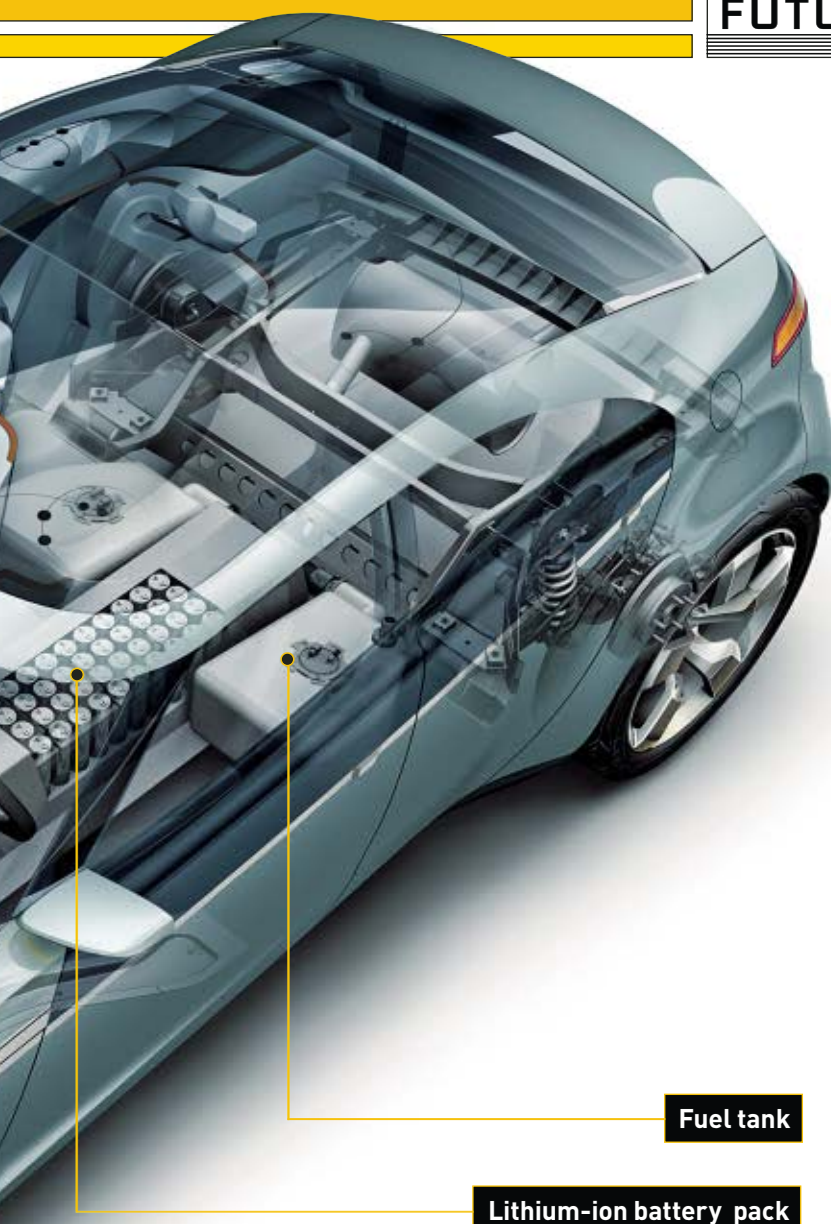
TECH Hybrid cars, which mate battery-powered electric motors with internal-combustion engines, are available now from Honda, Toyota and Ford, and most other manufacturers have models on the way. All-electric cars, including the Tesla Roadster [see "Can 6,831 Laptop Batteries Change the World?" page 68], are having a harder go of it, mostly because of the limitations of current battery technology. The Chevy Volt concept [left], unveiled this year, cleverly straddles the fence between hybrid and all-electric cars. The Volt uses a 1.0-liter, three-cylinder gasoline engine *only* to charge a lithium-ion battery pack (yet to be developed) that powers the 120-kilowatt (160-horsepower) motor. Owners could also charge the Volt using a household outlet.

GREEN BENEFITS The Toyota Prius, a conventional hybrid, gets between 45 and 50 miles per gallon and produces half the amount of greenhouse-gas emissions of 30mpg sedans. If GM's Volt happens (battery technology won't be ready until at least 2010), it could drive on electricity alone for about 40 miles. That 40-mile-or-less drive describes 78 percent of American commuters. Even if the Volt drew its power from the dirtiest coal-fired plants, it would still produce less than half the emissions of a typical new car.

ECONOMICS Over 15,000 miles, the Prius costs an estimated \$650 to fuel, compared with \$1,300 for the 27mpg Toyota Camry. Driving the Volt 15,000 miles on electricity alone would cost only about \$300 on the electric bill. Owners who drove 60 miles a day would see 150 miles per gallon and an average annual fuel cost of \$116. But delivering a family car like the Volt at a price people could swallow—figure \$25,000 in today's dollars—will be an enormous challenge.

OUTLOOK The first plug-in hybrids won't arrive before 2011; lithium-ion batteries have to get stronger, smaller and much cheaper to make the Volt viable and affordable for the masses. In the meantime, conventional hybrids will continue to dominate the alt-fuel market.

EST. MARKET SHARE IN 2027: 30%



Fuel tank

Lithium-ion battery pack

Charging outlet

1.0-liter, three-cylinder turbocharged engine

Generator

Electric drive motor

VOLT FROM THE BLUE General Motors made a huge splash at the Detroit auto show in January when it unveiled its Chevy Volt concept. The car is designed to run on electricity alone, with batteries that can recharge either via an external outlet or an onboard gasoline engine, delivering 150 miles per gallon for drivers who commute up to 60 miles a day.

NATURAL GAS

PROS: CLEAN, ABUNDANT, DOMESTIC
CONS: FEW PUMPS, NONRENEWABLE

Natural gas, the cleanest-burning fossil fuel, heats half of the homes in the United States. Why not siphon a bit off for your car?

TECH Natural gas, which is extracted from oil fields and natural-gas fields found around the world, burns cleaner than other fossil fuels and produces up to 30 percent less carbon dioxide than petroleum does. Honda's Civic GX—the only compressed-natural-gas (CNG) car available to consumers—burns the fuel in a 1.8-liter, four-cylinder, 113-horsepower engine. It can travel about 240 miles on a tank that's pressurized to 3,600 psi and holds the equivalent of about eight gallons of gasoline. Pumps are scarce, with most used to service small municipal fleets. Companies are experimenting with home fueling stations, such as FuelMaker's Phill.

GREEN BENEFITS The natural-gas Civic is the cleanest internal-combustion car ever tested by the Environmental Protection Agency. It's less polluting than any gasoline or even hybrid model, and it consumes on average 0.1 barrel of petroleum annually (in engine oil), compared with 6.9 (gasoline and oil) for the Civic Hybrid and 10.4 for the conventional Civic. Natural gas, widely available from domestic sources, might reduce dependence on foreign oil. (CNG cars are found across Europe and the Middle East; there are an estimated one million CNG cars in Italy alone.)

ECONOMICS The Phill home fueling station costs \$3,500, plus about \$1,000 for installation, though a \$1,000 federal tax credit (along with possible state tax credits) helps offset the cost. Natural gas from Phill costs only about \$1.30 per gasoline-gallon equivalent. It pollutes less per mile and has about the same overall mile-per-gallon numbers of a comparable gasoline engine. The natural-gas Civic GX is rated at 28 miles per gallon city and 39 highway (gasoline-gallon equivalent); a comparable gasoline engine gets 30/40 miles per gallon, and the Civic Hybrid is rated at 49/51 miles per gallon. The GX costs nearly \$6,000 more than the gas model and \$2,000 more than the hybrid, though a federal tax credit of \$4,000 takes a large chunk out of that sticker price.

OUTLOOK As clean and plentiful as natural gas may be, it faces the serious question of acceptance by the public and major infrastructure obstacles—in the absence of easily accessible public fueling stations, the Phill device is the only thing making the car even remotely viable for consumers. Natural gas is also a fossil fuel, with a finite supply, although the U.S. obtains a much larger proportion of natural gas from domestic sources than it does oil.

EST. MARKET SHARE IN 2027: 3%



GAS, AU NATUREL PopSci's automotive editor, Eric Adams, gases up the Civic at his home in New Jersey. It was the first residential installation of the home fueling station on the East Coast.

TEST: HONDA CIVIC GX

POPULAR SCIENCE'S long-term evaluation of the natural-gas-powered Honda Civic and the FuelMaker home fueling station suggests strong potential—if owners accept the limitations **BY ERIC ADAMS**

2007 HONDA CIVIC GX Our CNG Civic is proving to be a uniquely challenging test subject. On one hand, there's a very convincing economic and environmental case for it; on the other hand, driving it can be an awfully nerve-wracking experience when the fuel gauge approaches the end of its plummet to empty. The car serves as both a daily commuter from Scotch Plains, New Jersey, to New York City and a weekend daytripper for the editorial staff. Our test is pushing the limits of the car's intended primary use as a commuter car—that is, not necessarily a primary family vehicle—and of the current public-access refueling infrastructure, which is limited to a handful of pumps in most states. Although drives to Boston and Washington, D.C., went off without a hitch, other trips were problematic.

Assistant editor

Bjorn Carey, driving with friends 120 miles to a wedding in Hartford, Connecticut, left with half a tank, planning on refueling in Greenwich.

TEST RESULTS

Weeks in service: 30
Total mileage: 7,100
Observed average fuel economy (est.): 36 mpg
Estimated fuel cost: \$280

JOHN B. CARNETT



& FUELMAKER PHILL

When they arrived at that station, the attendant said, “You must not be from around here” before explaining that the pump had been out of order for four months. Carey made a white-knuckle drive to a station in East Hartford by setting the cruise control at 63 miles an hour and drafting behind big trucks. He pulled in with 243 miles on the tank, a staff record. (Honda estimates the range at 240 miles.)

I actually did run out of gas once, but only 50 feet from my driveway. Fortunately, I knew a secret by then: If you run out of gas, just turn the car off, wait a few minutes, and restart it. The tank repressurizes itself and pushes dispersed fuel into the system, giving you a few more miles.

FUELMAKER PHILL The home refueling station has been convenient and reliable. The slow refuel time (16 hours from empty, whereas public stations fill in two or three minutes) has never been a problem, since I’ve gotten into the habit of topping it off each evening. With its safety features—a leak detector, automatic shutoff and breakaway fueling line—it has never given us cause for concern. In my neighborhood, however, which is an older community with low-pressure gas lines, Phill shuts down automatically when the pressure drops below a certain point, as happens when cold weather sets in and the heating systems run full-time. The local gas utility, Elizabethtown Gas, upgraded the gas lines and meter to help solve the problem—something utilities generally do at no expense to the customer—and FuelMaker is developing a software fix to accommodate the lower pressure.

COURTESY VOLVO

FIVE WAYS Volvo’s Multi-Fuel concept car can run on five different fuels, including ethanol.



ETHANOL

PROS: RENEWABLE, DOMESTIC
CON: ENERGY-INTENSIVE

Corn-based ethanol won’t meet our energy needs, but cellulosic ethanol could reverse its fortunes

TECH Ethanol is ethyl alcohol, brewed in the U.S. mainly from corn. The idea has been that this starch-based kind of ethanol could replace petroleum with an endlessly renewable fuel. Millions of flex-fuel vehicles are indeed on the road, able to burn gasoline or E85, a blend of 85 percent ethanol and 15 percent gasoline. But nearly all those vehicles run exclusively on gasoline because there are roughly 1,100 ethanol pumps nationwide, almost all of them in Midwestern corn-growing states. The great hope is for commercial development of cellulosic ethanol, produced by a network of local facilities from handy field waste, such as corn stover, switchgrass or wood pulp.

GREEN BENEFITS Proponents tout the environmental benefits of ethanol, and a University of California at Berkeley study found that ethanol from corn cuts greenhouse-gas emissions by 10 to 15 percent compared with gasoline. Nice, but not great. Cellulosic ethanol, on the other hand, can be made from crops that take less energy to grow or from agricultural waste.

ECONOMICS It costs automakers only \$50 to \$150 to equip a gasoline engine to also accept E85. But ethanol is expensive to transport and, with its poor energy density, it gets about one third worse mileage than gasoline. Plus, the corn-based variety costs much more than gasoline when purchased outside the corn belt.

OUTLOOK Corn-based ethanol—which is heavily subsidized—produces significantly reduced mileage and debatable CO₂ reductions. Cellulosic ethanol could alleviate production and distribution problems, but researchers haven’t yet figured out a cheap way to produce it.

EST. MARKET SHARE IN 2027: 6% (E85)

MAJOR MUSCLE The forthcoming Audi Q7 TDI produces 738 pound-feet of torque from its 6.0-liter V12 diesel engine.



DIESEL

PROS: GREAT MILEAGE, AVAILABLE NOW
CON: STILL MADE FROM OIL

Its low sulfur content and sophisticated exhaust cleaners set the stage for a big diesel comeback

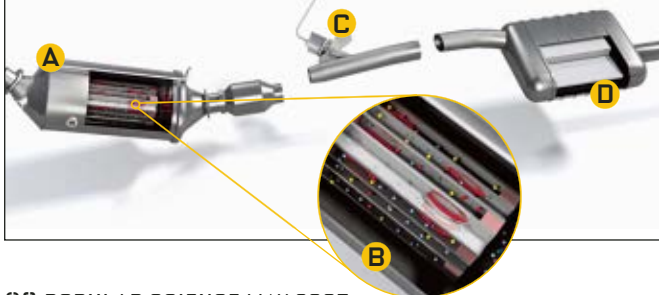
TECH Formerly dirty and noisy, diesel is enjoying an eco-friendly second act. Environmentalists are calling the new federally mandated, ultra-low-sulfur diesel—introduced last summer—the most significant green advance in transportation since gasoline got the lead out in the 1970s. The cleaned-up fuel lets automakers introduce new systems to scrub smog-forming nitrogen oxides that are emitted as part of diesel exhaust, along with filters to trap diesel's sooty, carcinogenic particles. Mercedes's upcoming Bluetec models will carry a refillable tank of urea, an additive that converts nitrogen oxides to harmless nitrogen and water; VW, Audi and Chrysler will adopt Mercedes's technology. One-upping that approach,

Honda will introduce by 2009 a nitrogen-oxide catalyst that achieves 50-state pollution standards with no urea additives. Diesels from Mercedes, Volkswagen and Jeep are on sale now, though not in the five states that set stricter pollution rules, including California. But the 50-state-compatible diesels from Volkswagen and Mercedes (its Bluetec models) are slated to arrive later this year.

GREEN BENEFITS Between their energy-rich fuel and their efficient combustion, diesel cars have always delivered 20 to 40 percent better mileage than gasoline models. They also happen to emit about one third less carbon dioxide.

MERCEDES BLUETEC DIESEL

An oxidizing catalytic converter [A] limits carbon monoxide and hydrocarbons in the exhaust, which enters a particulate filter [B] and is injected with urea [C], which helps a final converter [D] turn nitrogen oxides into nitrogen and water.



ECONOMICS Mercedes charges \$1,000 extra for its diesel engines; owners would save enough at the pump to offset that cost within two or three years. The Mercedes E320 Bluetec we tested delivered a remarkable 38 miles per gallon on the highway, a 40 percent gain over the same sedan with a gasoline V6. And when 50-state diesels arrive, many should qualify for a tax credit of up to \$3,400.

OUTLOOK Diesel is cleaned-up, available at pumps coast to coast, and offers genuine savings to consumers. The ultra-low-sulfur fuel requirement will help it grow over the next two decades.

EST. MARKET SHARE IN 2027: 20%

BIODIESEL

PROS: CLEAN, HIGH-ENERGY
CONS: LIMITED SUPPLY AND MARKET

Already common in Europe, biodiesel could get traction here as well—but it needs for regular diesel to catch on first

TECH Cleaner-burning than ethanol, with vastly better fuel economy, biodiesel could soon move beyond the fryer-grease fringe it's often associated with. Made largely from soybean oil or recycled cooking oil, biodiesel runs fine in unmodified diesel engines at up to a 20 percent blend with 80 percent petroleum diesel, a combination known as B20. Mercedes is conservative with its warranted vehicles, recently announcing that drivers of Bluetec and CDI diesels could run B5; the same is true for Jeep's Liberty and the upcoming Grand Cherokee diesel. (In Europe, Citroën and Peugeot diesels can run up to B30.) Pure liquid biodiesel thickens at low temperatures, however, creating challenges for cold-climate storage and operation.

GREEN BENEFITS Biodiesel's greenhouse-gas emissions are about one third lower than gasoline. A University of Minnesota study found that biodiesel creates 93 percent more energy than is used to produce it, compared with just 25 percent for ethanol.

ECONOMICS B20 fuel contains only 2 percent less energy than regular diesel, so it delivers terrific mileage: 20 to 40 percent better than gasoline. Prices vary by region because of the limited supply sources, and it costs more than either gasoline or petroleum diesel.

OUTLOOK Despite efforts toward large-scale biodiesel production, for now it's a mere drop in a huge national reservoir of gasoline. Just 225 million gallons were produced in the U.S. last year, about as much gasoline as the nation guzzles in a day. There are only about 1,000 pumps nationwide, and any growth in that number depends on a rise in diesel usage. Biodiesel has better prospects in Europe, where diesel holds half the car market and the European Union produces nearly 90 percent of the world's biodiesel.

EST. MARKET SHARE IN 2027: 4% (B20)

BIO BENZ Mercedes's E320 can run on 5 percent biodiesel.



CLEAN AND LEAN Redesigned fuel-cell stack helps Honda's new FCX adopt a more stylish profile.

HYDROGEN

PRO: ZERO EMISSIONS
CON: ENORMOUS INVESTMENT NEEDED

Hydrogen remains the gold-standard for eco-friendliness, but its prospects are dimming as reality sets in

TECH Hydrogen-fuel-cell cars employ an electrochemical converter that combines hydrogen and oxygen to create electricity that powers a motor, with heat and water as the by-products. Honda's new FCX model, which looks like a Prius by way of Modena, features a more compact second-generation fuel-cell stack that offers a 270-mile driving range. Honda will lease a handful of FCXs to private fleets and selected customers next year. Ford, BMW, GM and Chrysler are also testing hydrogen models; this year BMW will tap a few customers to test versions of a 7-Series luxury sedan whose V12 engine burns liquid hydrogen or gasoline.

GREEN BENEFITS Hydrogen offers a tantalizing zero-emissions possibility: an abundant element that makes electricity and gives off just water—no tailpipe emissions or carbon dioxide. But it's only a zero-emissions fuel if the hydrogen comes from renewable sources.

ECONOMICS Hydrogen reformed from natural gas could eventually be produced for \$3 or \$4 a kilogram (a kilogram of hydrogen has roughly the same energy as a gallon of gasoline). Because a hydrogen-fuel-cell vehicle could deliver double the mileage, the fuel could be competitive with gasoline at just \$1.50 or \$2 a gallon. But automakers will need to see a wholesale transformation of the energy industry to convince them to invest billions of dollars in the technology.

OUTLOOK Despite the technological dog-and-pony shows, no automaker is close to bringing hydrogen cars to showrooms. Hydrogen skeptics insist that its production inefficiencies doom it as a fuel for passenger cars. By the time the tech is ready, hybrids, diesels, plug-ins and other fuel-sippers will only have gotten better, cleaner and more affordable—and harder to dislodge in the market.

EST. MARKET SHARE IN 2027: 2%



ON THE ROAD The tiny Smart ForTwo will officially hit U.S. highways early next year.





They had one week, 1,500 miles and, oh, about \$100 in gas money to answer the question:

IS AMERICA READY TO GET SMART?

BY MCKENZIE FUNK



THREE KEY FACTS

- 1** Since 1998, more than **770,000 two-seat Smart cars** have been sold in Europe.
- 2** The car **can get 60 mpg** and has crash-test ratings better than other small cars.
- 3** The revamped 2008 model—the first available in the U.S.—will have a **big-ger engine and more horsepower**.



DETROIT TO MARSHALL, MICHIGAN

2.21 gallons, \$5.83, 48 miles per gallon

"How about y'all get in the back. Just put you and your entire car in the back, and I'll take you wherever you want to go."—Chevy Tahoe driver in downtown Detroit

The Rouge, Henry Ford's 2,000-acre icon of American industry, a complex of steel furnaces and railroad tracks and twisting assembly lines just outside Detroit, makes trucks. It didn't always make trucks. Starting in 1917, it made anti-submarine boats, then it made tractors, and then it made cars: Model A's, V8s, Thunderbirds and four hallowed generations of Mustangs. In the 1930s it was the largest auto plant in the world, toured by queens, presidents and rival barons, and what it built, it built from scratch. It had 100,000 employees in 93 buildings who produced 1,500 tons of iron and 500 tons of glass a day. A hunk of raw iron became a vehicle in 72 hours. The Rouge spit out a new car every 49 seconds.

But today the modernized Rouge spits out only trucks—red F-150s, white F-150s, black F-150s—enough Ford trucks in three days to stretch bumper-to-bumper to downtown Detroit, nine miles away. Enough trucks in five months to stretch bumper-to-bumper to New York City. Enough trucks to meet what for so long has seemed an insatiable demand for the full-size, 200-plus-horsepower pickup, America's best-selling vehicle for 25 straight years and best-selling truck of all time. Enough trucks to make me and my girlfriend, Jenny, look like heretics when we pull into the Rouge-tour parking lot. No, worse than heretics—like Europeans.

The car we're driving is the Smart car, an eight-foot-long product of France that gets upward of 40 miles per gallon to the F-150's 15 mpg. It has two seats and three cylinders and a 0.7-liter, 61-horsepower engine. It is shorter than a golf cart. It can park headfirst in a parallel spot. When we drive it, heads turn and cameraphones get pulled out, and other drivers, trying to figure out what it is, tailgate us so closely that we worry about accidents. Some signal us to roll down our window as we're going 75 on the freeway.

Sold in Europe for nearly a decade—770,000 cars in 36 countries and counting—the Smart is coming to U.S. shores in the most talked-about launch of 2008. Already a 44-city road show is kicking off. Drivers from New York to Miami to Seattle to Austin, Texas, will be able to see the Smart, sit in it,

and take it for a spin. A Web reservation system is up and running. Go to smartusa.com, pay a refundable \$99, and you're on the list to get one of the first American Smarts to roll off the line.

Jenny and I got our Smart—a gray-market version imported from Europe and made street-legal here—the old-fashioned way: We rented it from a Budget franchise in the Chicago suburbs. We brought it to Detroit to begin a makeshift road show of our own, a 1,500-mile jaunt through the heartland in which we try to answer a simple question: Is America ready to embrace such an un-American ride?

Inside the Rouge, we join a tour with a pair who are obviously spies from China, ill disguised as tourists, and a couple of Orthodox Jewish teenagers in formal wear on an apparent first date. We watch a video about the plant's history, set to an original score by the Detroit Symphony Orchestra, and are shuttled into a planetarium-like room of swiveling chairs for a full-sensory "what it's like to become

PRECEDING PAGES: MAIN PHOTO: MCKENZIE FUNK;
TOP, FROM LEFT: MCKENZIE FUNK; NUMBERS 1, 4
AND 5; JOHN B. CARNETT; NUMBERS 2, 3 AND 6



SIZE MATTERS Sharing the road south of Memphis. Far left: ordering at Lou Mitchell's diner, on Route 66. Below, left: planning the route.

our tiny car, I can't shake the feeling that the factory of the future is pumping out what may be the vehicle of the past.

MARSHALL, MICHIGAN, TO WILMINGTON, ILLINOIS

7.89 gallons, \$20.19,
37 miles per gallon

"Your car should make other people smile. It should make you smile. Anybody can sit in traffic in a Taurus, you know?"

—Ron Durchin, car collector and Budget franchise owner near Chicago

Interstate 94 through Michigan is broad and straight, and before Jenny and I pull into the Shell station in Marshall, we've been cruising in sixth gear at a steady 85 miles an hour. The ride has been smooth, so much like that of a normal sedan that

a Ford F-150" presentation. It involves crashing sounds, piped-in smells, and bursts of patriotic welding and smelting shown on innumerable wraparound movie screens.

What goes unsaid is that F-150 sales have been tanking of late, along with full-size SUV and pickup sales in general, a decline that economist Steven Szakaly of the Center for Automotive Research says is a fundamental "structural shift." As gas prices began to climb above \$3 a gallon last July, Ford's truck-division sales fell by 44 percent. Domestic rival General Motors's fell by 28 percent. Ford ended the year with the worst losses in its 103-year history—\$12.7 billion, more money than the GDP of 82 of the world's countries—and Chrysler announced plans to close four plants and cut 13,000 jobs after a \$1.5-billion loss of its own. Both manufacturers' U.S. sales were overtaken by Toyota's. For the first time, the Big Three weren't the big three anymore.

After a display of the Rouge's environmental rebirth—songbird habitat, revitalized wetlands, a 10-acre "living roof" that's the largest in the world—we watch F-150 shells flow through a four-mile-long assembly line. Robots use lasers to place windshields with perfect precision; United Auto Workers unionists in street clothes use mechanical arms to lift heavy parts. Everything is smooth, bright, orderly, laudable—and oddly anachronistic. As we get back into

it's still a shock when I step out the Smart's driver-side door and am already at the back of the car. "Whoa, that looks like Urkel's car," says a long-haired gas-station attendant. "Geeks of the world, unite!" adds his co-worker. This guy—thin, wearing thick glasses, terminally awkward—is named Pete. He sells us two window-mounted plastic cup holders for \$1.69 apiece (our European Smart lacks these, although it does have a huge ashtray; the second-generation model that's coming next year corrects the oversight) and then asks if he can sit in the Smart. Pete slides his long frame into the driver's seat and looks around, taking in the car's surprisingly spacious fishbowl interior. He messes with the gearshift and adjusts the mirror. He grasps the wheel with both hands. "Sweetest," he squeaks. "Huh. I might have to get one myself."

Steve Urkel, the nerd-star of the 1990s sitcom *Family Matters*, drove an Isetta, a BMW-built bubble car that was one of the most successful micros in post-World War II Europe. With three wheels and a windshield-cum-front-door, Urkel's car must have been the prop department's dream come true. As an example of a car that reflects its

SMALL BUT PROUD From left: Jenny takes the wheel in downtown Detroit; Smart owner Ron Durchin at his Illinois auto-body shop; quite a stretch in Detroit.



driver's personality, it's hard to match. Although the psychology of car buying is murky—in market surveys, owners can always come up with a “need” that explains their desire—certain vehicles are clearly meant to appeal more to the senses than to a sense of utility. Here in Marshall, we're witnessing a burst of geek emotion over the Smart, something that has everything to do with image and little to do with practicality. “I don't like the storage space,” Pete says. “But . . . sweet.”

A few hours down the road, Jenny and I make a detour to meet Ron Dorchin, a man infected with a similarly impractical love of the Smart and the owner of the only agency in the country that will rent you one. A tall, gregarious car freak whose father opened Chicago's first Budget franchise 38 years ago, he had invited us to his new 40,000-foot body shop, AutoWerks, the largest in the Midwest. There, inside a cavernous garage, he tells the story of his Smarts' arrival. After being converted for American roads by a California company, his six cars were stacked sideways on a semi and trucked out here. The truck driver took twice as long as usual, because every time he stopped, people peppered him with questions. The Smarts were finally dropped off outside the Budget office in Skokie. “We probably had 500 people stop by that first day,” Dorchin says. “It got so bad that we had to lock them, because every time we went outside, someone was sitting down in one.”

After import fees and conversion fees and transportation fees, the Smarts cost Dorchin about \$26,000 each. (Those coming directly to the U.S. market will be significantly cheaper; Smart estimates a price point below \$15,000 for the 2008 launch, with the *Wall Street Journal* reporting it at close to \$11,000 for an entry-level model.) Dorchin rents them for \$60 a day. His Web site's hits have gone up from 40,000 to 105,000 a month since he began using the cars for advertising, and he hopes for similar things for AutoWerks after he fixes up one of the Smarts to look like a Mercedes that's been smashed in on both ends. Still, for him, the appeal of the Smarts isn't altogether rational. He's not making any money off them, and when the fleet came in, he borrowed one of the cars for two months just so he could commute in it.

He ticks off a quick list of what he likes about the Smart



THE SMART'S INGENUITY IS THAT IT'S A NORMAL CAR. JUST SMALLER.

mechanically—its zippiness off the line, the steel safety cell that surrounds passengers, the fact that he can get 65 miles a gallon (I'm getting around 40, but I have a lead foot). Yet it's obvious that what he really likes is the spectacle. “You can take it to a bar or restaurant and have fun just watching people's reactions,” he says. “It's the car that comes with a social life.”

WILMINGTON, ILLINOIS, TO ST. LOUIS, MISSOURI 8.35 gallons, \$21.62, 33 miles per gallon

“If they made it even smaller, what would they call it? The half-wit?”—Bill Shea, Shea's Route 66 Gas Station Museum in Springfield, Illinois

Past Chicago, we leave the freeways in favor of an old alignment of Route 66, and the American road becomes The American Road. We've already passed the world's first McDonald's franchise, not far from O'Hare airport, and now we're passing the first Dairy Queen as well. Perhaps because so many weird

TOP: JOHN B. CARNETT; BOTTOM, FROM LEFT: VOLKSWAGEN AMERICA; DONNIE SOLOMON/GREMLINX.COM; AMERICAN HONDA MOTOR CO.

SMALL STEPS TOWARD A SMART FUTURE

1949 VOLKSWAGEN BEETLE 12 ft., 1,050 lbs.



The Beetle met a skeptical audience when it first appeared here right after World War II.

By the late 1960s, it had become an icon (thanks in part to Herbie, the automotive star of the 1969 movie *The Love Bug*). Five million were ultimately sold in the U.S.

1970 AMC GREMLIN 13.4 ft., 2,633 lbs.



The original design for the car considered by many to be the first American-

made subcompact was sketched on the back of an airline sick bag. By 1978, 671,475 cars had been sold, making the Gremlin AMC's best-selling model ever.

1973 HONDA CIVIC 11.65 ft., 1,536 lbs.



Until the Civic, Honda was known as a motorcycle company. The model was so

successful—43,119 were sold in its first full year on the market; the next year, sales doubled—that it helped establish the Japanese as the top maker of quality small cars.

FUTURE OF THE CAR: EFFICIENCY



WHAT WOULD ELVIS DRIVE? Far left: hunkered down at the Memphis-Graceland RV Park. Near left: Bill Shea at his Gas Station Museum. Above: the Crossroads café in western Illinois.

cars drive this route, nobody pays us much mind when we park the Smart below Wilmington's cone-headed, 28-foot-tall Gemini Giant, a fiberglass statue dressed as an astronaut, and run in to get burgers at the Launching Pad Drive-In. We get only a few stares when we drive through Dwight, home of the Waddle, an annual parade of hundreds of basset hounds.

Already we've brought the Smart beyond what's expected to be its natural range. It's a commuter car on a road trip, cruising the hinterlands, when some say it will appeal only to Hollywood types (*Hey, look at me, I'm an environmentalist!*) and to the urban creative class that's apparently ready to buy anything—iPods, RAZRs, you name it—that doesn't follow the proper rules of capitalization. (Smart, unlike *dear* copy editor, prefers to write its name as "smart.") Its competitor the Mini Cooper is officially the "MINI.") But Dave Schembri, the president of Smart USA, points to three segments beyond the urban hip where he expects the Smart to sell well: first-time buyers (low price), empty-nesters (seating

for two), and baby boomers looking for a second or third car ("It's perfect if you have a teenage daughter—no backseat"). Which is to say, Smart USA hopes that its market is just about everyone. "We're the rare vehicle with 50 percent emotional appeal, 50 percent rational appeal," Schembri says.

As we roll down Route 66, where automobiles were once escape pods for 1930s Dust Bowl refugees and a way of life for California-bound tourists in the 1950s, Jenny and I are entering a world dominated by that rational 50 percent—a world we hope will judge the Smart on its merits as a car, not a message. At Shea's Route 66 Gas Station Museum in Springfield, we peruse a collection of pumps, photos and motoring kitsch dating back 70 years. Bill Shea, the museum's wry 85-year-old owner, learns that I'm from Oregon and harangues me about all the climbers who keep dying on Mt. Hood. "If they don't have a purpose," he says, "then what in the hell is the point of being up there?" I tell him it's pretty. "They ought to put a restriction on people," he says. He pulls out an old point-and-shoot film camera and walks outside to snap a photo of the Smart. His assessment of it is typically no-nonsense. "Hmph. Not much room for hitchhikers."

2002 BMW MINI COOPER 11.9 ft., 2,315 lbs.



After an unorthodox advertising campaign (BMW put the cars on top of

SUVs and drove them around U.S. cities), the new version of the Mini Cooper caught on big. Since 2002, 180,000 have been sold, twice the number projected.

2007 ZAP OBVIO 8.7 ft., 1,328 lbs.



The American company ZAP (Zero Air Pollution) recently joined with Brazil's Obvio

to bring that country's curvy, flex-fuel vehicle here. ZAP says that demand is high for the unorthodox vehicle, which will have an initial U.S. run of 50,000.

2008 DAIMLERCHRYSLER SMART 8.8 ft., 1,807 lbs.



Since the Smart was introduced in 1998, 770,000 have been sold in 36 countries.

It's getting an upgrade just in time for its American debut: The 2008 model is six inches longer and has smoother shifting capabilities.

ST. LOUIS, MISSOURI, TO MEMPHIS, TENNESSEE

7.89 gallons, \$18.38, 34 miles per gallon

"I don't know what all it's supposed to do, but if it starts talking, I'm gone."—Marla, parking-lot security guard at Graceland's Rock 'n' Roll Café in Memphis

In the St. Louis suburbs, Jenny and I peel off Route 66 and join up with the Great River Road, a winding, sometimes hilly highway that parallels the Mississippi and is the stuff that car tests are made of. In its current incarnation, the Smart is said to top out at 85 miles an hour—though I've pushed it faster—and we're often the speediest thing on the road. I figure that its strange looks will inspire any cop who pulls me over for speeding to ask questions rather than issue tickets.

The Smart is not designed to be a road-trip car, but it's certainly a highway car—a Mercedes, after all. A product of DaimlerChrysler, it was born of a joint venture between the Swatch watch company and Mercedes, and it has a pedigree to live up to. The four wheels are literally at the four corners of the car—making for a

wheelbase of 71 inches, 22 inches shorter than a Porsche 911's—and we gun the Smart around turns, hugging the road. Its acceleration, panned by *Consumer Reports*, which tested a pokier diesel model, is noticeably weak only on uphill (though perhaps I've been numbed by the acceleration-proof 1989 Mitsubishi Montero that I normally drive). The main thing is that Jenny and I don't feel small. The cockpit is roomier than my own SUV's, we're sitting upright and high off the ground, and we don't notice that the back half of our car is missing when we're looking ahead at the blur of fields and shortleaf forests.

Our biggest gripe is the transmission, which is fine in (clutchless) manual mode but hopelessly jerky in automatic. Perhaps more annoying is a mysterious power down—some strange Euro security feature—that's triggered when we leave the parked car unlocked for too long. More than once we've found ourselves sitting in the darkened car, locking and unlocking its doors and shifting through the gears as we try to get it going again. But all this is set for an overhaul in the second-generation Smart. The new American model will also come with a bigger, 71-horsepower engine, and it will have a top speed of 90 miles an hour. As if to prepare for the gluttonous U.S. market, it's also rumored to get worse gas mileage.

As we approach Memphis, high winds and a rainstorm hit, and the Smart is blown back and forth in a way that's reminiscent



ROADSIDE

ATTRACTIONS

The Smart was a spectacle on most of the trip, but among the bizarre landmarks of Route 66, it couldn't compete. Left: The son and great-grandson of Gas Station Museum owner Bill Shea eye the little car.

of my box of a Montero. I need to keep both hands on the wheel. We take shelter at the Memphis-Graceland RV Park & Campground, where a Smart-size cabin is tucked away on the corner of Don't Be Cruel Lane, not far from Blue Suede Lane, Shook Up Lane and Hound Dog Way. The RV park has free Wi-Fi. A sign in the bathroom reads "Don't spit out tobacco in our washroom."

Elvis was a car lover, the owner of a pink Cadillac, a 1966 Rolls-Royce and a pair of 250-horsepower Stutz Blackhawks. But the closest thing to a Smart that we see when we tour his Graceland car museum the next morning is a red MG that he drove in *Blue Hawaii*. He eventually gave it to his secretary. We've left the Smart in a parking lot outside the Rock 'n' Roll Café, and when we get back a security guard named Marla in a cap and heavy coat tells us it's been drawing a steady stream of curious tourists. A Hyundai Sonata driver, she seems afraid to touch the Smart and circles it warily. She asks the usual raft of questions. What is it? Is it electric? Is it a hybrid? What kind of mileage does it get? She's surprised to learn that its basic ingenuity is that it's a normal car. Just smaller.

(CONTINUED ON PAGE 109)

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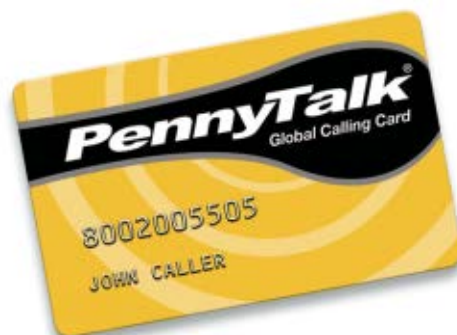
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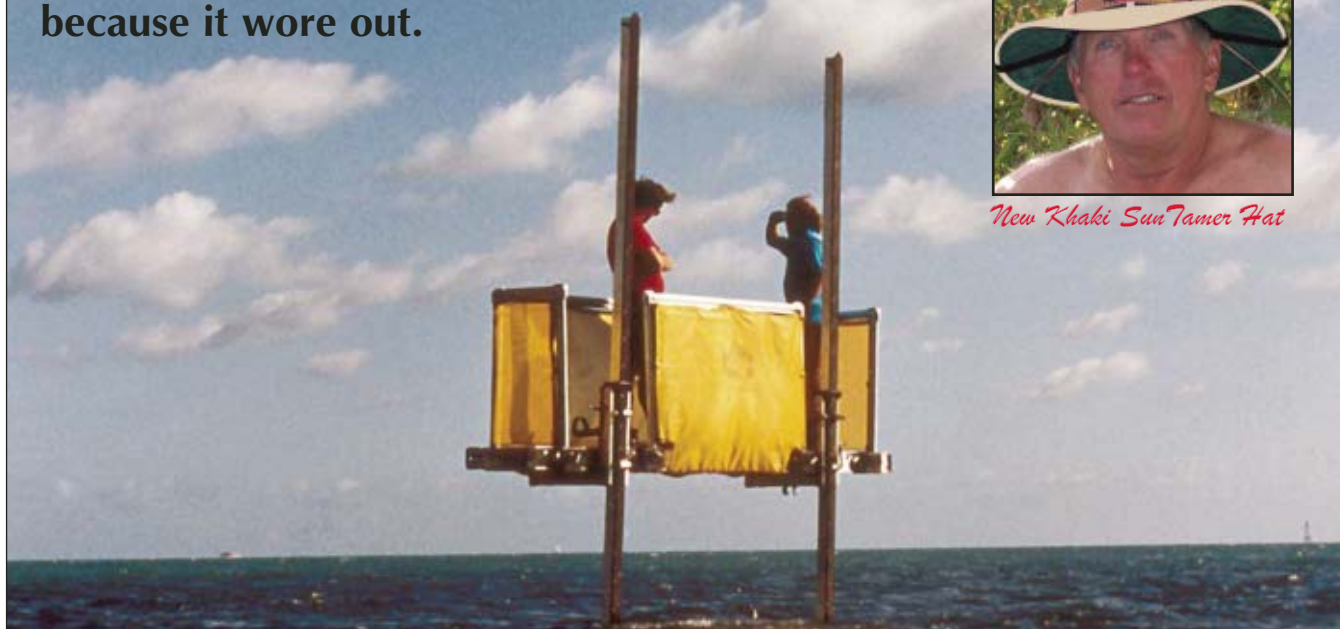
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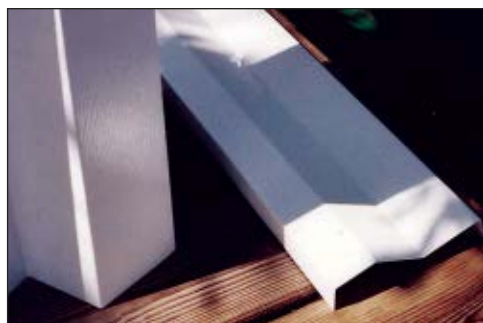
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HOW 2.



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Trick out your car with a computer



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Make your own massive spark plug



96

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MONSTER-CYCLE

HOW IT WORKS

\$80,000

3 YEARS

A half-ton drag-racing bike with the power of a monster truck

NICK ARGYLE'S SHOP was only big enough to work on a motorcycle, but his only engine belonged in a monster truck. So the 44-year-old British engineer did what any power-mad gearhead would do: He built a 1,000-horsepower, methanol-guzzling, two-wheeled colossus.

Argyle had two priorities. First, he had to keep the bike light despite its 800-pound engine. So instead of building a traditional, heavy drag-racing frame, he used the engine itself as the main load-bearing structure.

The next objective: keeping it short. Drag-racing motorcycles are very long and, as a result, don't turn well. But Argyle knew he'd need to ride on winding country roads to get to his local track, so he cut a foot off the length by sticking the supercharger belt—which helps generate extra power—between the forks, rather than behind them. The chariot may be shorter than its competitors, but the roar of 1,000 horses should make it clear who's in charge. —GREGORY MONE

FUEL The bike runs on alcohol-rich methanol, a common fuel for racers. Alcohol keeps the engine cooler than gasoline would. Methanol is cheaper, too—and at four miles a gallon, price is important.

SAFETY Argyle ran the exhaust pipes coming down from the cylinder heads wide and close to the ground. That way, if the back wheel kicks out during a race, the large pipes will scrape against the track and stabilize the bike, enabling the driver to right it.

PERFORMANCE Argyle hasn't clocked the bike's speed yet, but now that he's installed a new gearbox, he hopes to get it on the strip and top 200 miles an hour.

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FOR ALL THE TIME you spend in your car, you ought to get something done along the way. With an Internet-connected car PC stuffed out of sight and a touchscreen on the dash, you can e-mail a pal to get a restaurant recommendation, read reviews online, plug the address into the GPS software, and watch last night's *Colbert Report* while you're waiting for

your date. There are several ways to configure and install a system, and it's easier than you think. We designed a system-in-a-box that easily moves from car to car and runs entirely from one cigarette-lighter socket. See our guide to the parts below and the steps on the facing page, and you'll be a mobile info hub in practically no time.—DAMIEN STOLARZ

WHAT YOU NEED:

COMPUTER

WE USED: Apple Mac Mini (\$600; apple.com)

Any computer could work, but the simplest to install are compact PCs like Vizualogic's VMOD (\$700; vizualogic.com). We opted for a similarly sized Mac Mini since it runs both OS X and Windows. Like the VMOD, the Mini fits perfectly in the double-high slot where your factory stereo would go. Other ideal spots: in the glove compartment or under one of the front seats.

SCREEN

WE USED: Mp3Car.com's TRANS 7-inch VGA trans-flective (\$680; store.mp3car.com) and RAM's RAP-B-104-224U mount (\$23; gpscity.com)

A seven- or eight-inch touchscreen is big enough that it's easy to control and read but small enough to stay out of the way. Position it away from the car's other controls, and mount it securely. For a more factory-finished look, get it custom-installed in your dashboard. Prices start at around \$500.

POWER

WE USED: Carnetix CNX-P1900 (\$100; carnetix.com) Your car's 12-volt DC power can spike or sag to different voltages, so you'll need an adapter to regulate it. Look for one built specifically for a car computer, such as the P1900, which can run extra components like a USB hub and can put the computer to sleep when you turn off the car instead of just abruptly shutting it down.

SOFTWARE

WE USED: StreetDeck (\$200; streetdeck.com)

A number of software packages integrate navigation and multimedia playback. For a free option, try Road Runner (guino.home.insightbb.com).

INTERNET

WE USED: Verizon USB 720 modem (\$200 plus \$80/month; verizon.com)

For an always-on connection on the road, you'll need a cellular data modem, which gets near-DSL speeds in most places. We plugged in a USB model and ran it to the monitor mount. You can also use the Autonet Mobile router, which turns the car into a mobile Wi-Fi hotspot too. (\$400, plus \$50/month for service; goautonet.com).



3 KILLER APPS FOR YOUR INTERNET-CONNECTED CAR PC



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GOING MOBILE Get details on the portable system we built in this carbon-fiber-veneer wood box at popsci.com.

1. Wire the power regulator's input side to your car battery and ignition so that the computer remains powered even after you turn off the car.
2. Connect the regulator's output side to the computer. You may have to open the computer to bypass its power button. For a schematic, go to carnetix.com.
3. Plug the screen into the PC's DVI-to-VGA adapter. To power the screen, plug it into a lighter socket, or just wire it directly to the regulator.
4. Plug a sound cable from the computer's audio-out jack to the stereo's AUX-in port, or use a tape adapter or



MAC IN THE BOX The Mac Mini, power regulator and wires all fit neatly into the 4.5x11x16-inch enclosure.

FM modulator to hear the PC through your car speakers.

5. If you want, add a keyboard like the Mini-Key (\$25; store.mp3car.com).
6. Install the car-PC software.
7. Plug in the cellular modem, install any required software, and hit the road.

HOT PLATE Our monitor mount has a plate that holds the GPS dongle and modem.



5 THINGS...

YOU CAN DO TO MAKE YOUR CAR MORE GREEN

1 MAKE YOUR OWN GAS

Run your diesel car on homemade biodiesel fuel, which is cleaner, less expensive and better for your engine than the stuff you buy at the pump. Go to biodieselcommunity.org to get the delicious recipe of cooking oil, drain cleaner and methanol.

2 VEG OUT

Biodiesel not eco-friendly enough for you? Head to vegmyride.tv to learn how to modify your engine so that it runs purely on even cheaper and quieter-running recycled cooking oil. It's easier, too: To fill up, just head to a fast-food joint when the fryers are being cleaned out.

3 PLUG IN YOUR HYBRID

Kick up that Prius to 100 mpg by skipping the gas tank for local driving. Calcars.org will show you how to load any hybrid with batteries and mod it to charge from a standard outlet. Keep your speed down to stay on electric, and over time you will defray much of the \$5,000 cost of the project.

4 RUN IT ON BATTERIES

Say good-bye to gas altogether by converting your ride to run entirely off a hoodful of rechargeable battery power. Many different car models can be modded—check out austinev.org for instructions, help finding parts, and listings of electric vehicles for sale.

5 ONLY DRIVE VIRTUALLY

The gearheads at realvirtualcar.blogspot.com hacked an old Renault and turned it into the ultimate driving simulator. The car's original steering wheel and gauges all still function, but now they're used to maneuver the driver through a virtual Nascar race. —DOUG CANTOR

GRAY
MATTERSPARK OF
DESTRUCTION

The plugs inside your car fire a charge hot enough to wear away metal. Here's how to re-create that process, only bigger

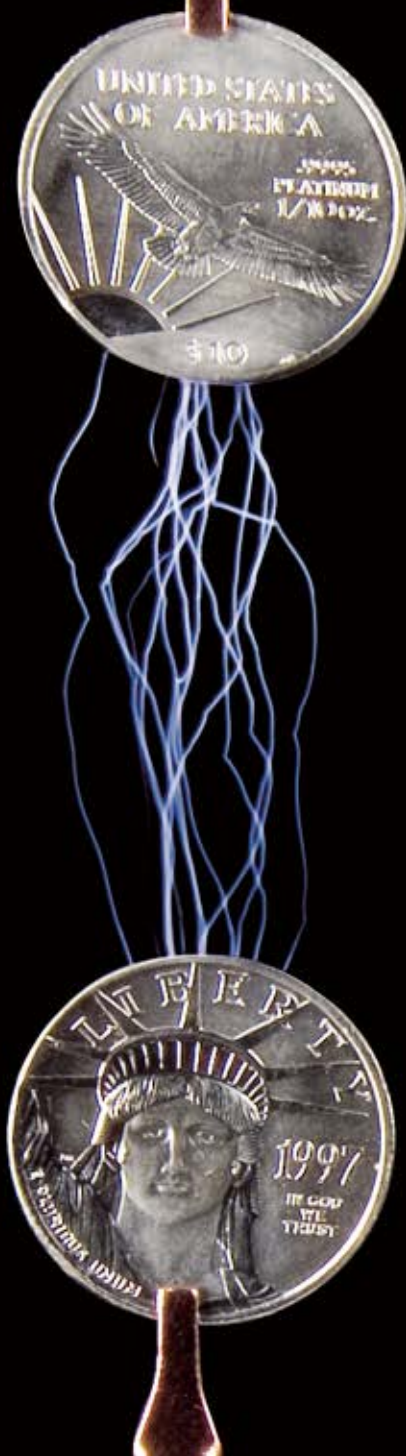
A SPARK PLUG is one of those humble, anonymous things without which the world would grind—or rather coast—to a halt. And like many underappreciated cogs in the machine, it has a really hard life. A good modern plug will endure 300 million sparks (around 20 per second) over 100,000 miles, each one triggering an explosion around its head as the fuel combusts, driving the engine's pistons (and thus, your car). But the spark itself is far more destructive than the bang. Cylinders, pistons and valve heads made of steel easily withstand the explosive abuse, but spark plugs made of steel would last just about long enough to get your car to the shop to buy new spark plugs.

On a molecular level, every spark is a hot tongue of superheated plasma crashing into the electrode at nearly the speed of light, heating a microscopic spot on the surface to thousands of degrees and blasting away a few billion atoms. Worse, the spark brings with it corrosive gases eager to react with the metal surface, forming insu-

lating coatings that render it useless for sparking. What you need is a metal with a high melting point that stays shiny (clean metal sparks better) under extreme conditions. The technical term for such a metal is "expensive."

Early spark plugs made of copper, nickel or chromium alloys were ill prepared for these conditions, making their lives nasty, brutish and short. But over time, parts makers started using corrosion-resistant noble metals like gold, platinum, palladium and iridium. High-end plugs today cost \$10 instead of \$2, but they last nearly the life of the car. Modern metallurgy has given today's spark plug a much different life than its ancestors. Now it's nasty, brutish and long.—THEODORE GRAY

SPARK FLOWER
An assortment of old and new spark plugs, including an antique tungsten tractor plug and a discontinued gold-palladium plug



HOT TIP A scaled-up re-creation of the tips of a modern platinum spark plug, using 1/10-ounce platinum coins for electrodes

POWER PLAY
This 60,000-volt Wimshurst generator safely supplies the juice for a two-inch spark.



MAKE YOUR OWN SPARKS

20 MINUTES

\$270

SAFE ||||| CRAZY

1. Get a Wimshurst machine [Left] of the size intended for classroom demonstrations (starting around \$120; try scientificsonline.com), which generates static electricity with two counter-rotating plastic-and-aluminum disks.
2. Connect two of the most expensive coins you can find to simulate gold, palladium or platinum spark-plug tips. (The electrodes that come with the machine simulate cheap nickel-chromium tips.)
3. Crank it up, and watch the sparks fly! With a machine this size, touching the electrodes is a shocking, but rarely harmful, adventure.

ACHTUNG! Don't try this at home without proper lab-safety procedures and equipment. Find more on Gray's scientific pursuits at periodictabletable.com.

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A DIY CAR AIR FRESHENER*



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DIY: 1. Empty and wash out a baby-food-size jar with a metal lid. 2. Carefully punch small holes in the lid. 3. Fill the jar with coffee beans, put it in a secure spot in the car, and inhale.



HAVE AN IDEA FOR A 5-MINUTE PROJECT? Send it to us at h20@time4.com.

*Originally posted on chalkline.blogspot.com

CAR TRICK OF THE MONTH



SEND MESSAGES TO OTHER DRIVERS

ON THE ROAD, you sometimes need to communicate with another driver using more than just a hand gesture. To say what you really mean, print a file from blog.johnath.com that has messages like "Sorry" and "Call Tow Truck" written in large type, or come up with your own. Then laminate, bind, and add file tabs to the pages so you—or better yet, a passenger—can quickly and safely hold up your message.—DOUG CANTOR

WEB SITE OF THE MONTH: KNIGHTREPLICAS.COM

BE A REAL-LIFE KNIGHT RIDER

Tap into the huge network of KITT replica enthusiasts to get a wealth of resources for building your own version of the talking Trans Am.



CLOCKWISE FROM BOTTOM LEFT: LUIS BRUNO (4); UNIVERSAL TV/EVERETT COLLECTION

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*St. Joseph Sleep Study.

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ASK A
GEEKHOW CAN I CONNECT MY
IPOD TO MY CAR STEREO?GOT A QUESTION FOR OUR GEEK CHORUS? Send it to us at h20@time4.com.

THAT DEPENDS on your budget. A common, yet not ideal, solution is an FM modulator like DLO's TransDock (\$100; dlo.com), which plugs into your iPod and broadcasts to your stereo through an open radio station. If your car has a tape deck, a cassette adapter is more reliable.

At the next level are auxiliary input interfaces, such as Soundgate's TOYPD (\$300; soundgate.com), small boxes that can deliver CD-quality sound using a cable that connects to the back of the stereo and another that plugs into your iPod. Or go to hackaday.com to learn how to add an inexpensive auxiliary jack to the stereo yourself.

To get the best sound and the most features, replace your factory stereo with a head unit featuring a port for connecting your iPod directly. A number of iPod-ready models, like Alpine's iVA-W205 (\$1,000; alpine-usa.com), offer built-in screens, so you can browse through your song collection, view album art, or even watch video files right on the unit. It's an expensive solution, but you can save some money by installing it yourself. Find directions and advice for many different cars and head units at carstereo.com.

BEN OH is the editor of *Car Audio and Electronics* magazine (caraudiomag.com).

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Amazoy is the Trade Mark registered U.S. Patent Office for our Meyer Zoysia Grass.

Mow your zoysia lawn once a month—or less! It rewards you with weed-free beauty all summer long.

7 Ways Your Zoysia Grass Lawn Saves You Time, Work, and Money!

1 CUTS WATER BILLS AND MOWING AS MUCH AS 2/3

Would you believe a lawn could be perfect when watered just once? In Iowa, the state's biggest Men's Garden club picked a zoysia lawn as "top lawn – nearly perfect." Yet, this lawn had been watered only once all summer to August!

In PA, Mrs. M.R. Mitter wrote "I've never watered it, only when I put the plugs in...Last summer we had it mowed 2 times...When everybody's lawns here are brown from drought, ours stays as green as ever." *That's how zoysia lawns cut water bills and mowing! Now read on!*

2 ENDS RE-SEEDING NEVER NEEDS REPLACEMENT

Plug in our zoysia grass and you'll never have to spend money on grass seed again! Since you won't be buying seeds, you won't need to dig and rake – then hope the seeds take root before birds eat them or the next hard rain washes them away.

3 NO NEED TO DIG UP OLD GRASS

Plant Amazoy in old lawn, new ground, whatever. Set 1" square plugs into holes in the soil 1 foot apart, checkerboard style. Plugs spread to drive out old, unwanted growth, weeds included. Easy instructions with your order. If you can put a cork into a bottle, you can plug in Amazoy.

4 FOR SLOPES, PLAY AREAS, AND BARE SPOTS

You can't beat Amazoy as the low cost answer for hard-to-cover spots, play-worn areas, or to end erosion on slopes.

5 IT STAYS GREEN IN SPITE OF HEAT AND DROUGHT

"The hotter it gets, the better it grows!" Plug-in zoysia thrives in blistering heat, yet it won't winter kill to 30° below zero. It just goes off its green color after killing frosts, begins regaining its green color as temps. in the spring are consistently warm. Of course, this varies with climate.



Thrives from part shade to full sun.

Every Plug GUARANTEED TO GROW IN YOUR SOIL No Ifs, Ands Or Buts!
Read a guarantee no grass seed can match!

Won't Winter Kill. Amazoy has survived temperatures to 30° below zero!

Won't Heat Kill. When other grasses burn out in summer drought and heat, Amazoy remains luxuriously green.

Any plug failing to grow in 45 days will be replaced **FREE!** To insure maximum freshness and viability, plugs are shipped not cut all the way through. Before planting, finish the separation with shears or knife. Our guarantee and planting method are your assurance of lawn success backed by more than five decades of specialized lawn experience!

6 CHOKES OUT CRABGRASS AND WEEDS ALL SUMMER

Your established Amazoy lawn grows so thick, it simply stops crabgrass and summer weeds from germinating!

7 NO NEED TO SPEND MONEY ON DANGEROUS CHEMICALS

Since zoysia lawns resist insects AND diseases, you avoid the risk of exposing your family or pets to weedkillers and pesticide poisons. Plug in Amazoy and save the money, avoid the risks!

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☐ 4 Basic Packs + 2 FREE	400	200	Free Step-on Plugger	\$ 56.65	\$31.80	\$ 7.50	40%
☐ 5 Basic Packs + 3 FREE	500	300	Free Step-on Plugger	\$ 72.55	\$39.75	\$10.00	42%
☐ 6 Basic Packs + 4 FREE	600	400	Free Step-on Plugger	\$ 88.45	\$47.70	\$12.50	44%
☐ 9 Basic Packs + 7 FREE	900	700	Free Power Plugger	\$152.15	\$71.55	\$15.00	50%
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☐ Extra Step-on Plugger \$8.95				☐ Extra Power Plugger for 3/8" Drill \$24.95			

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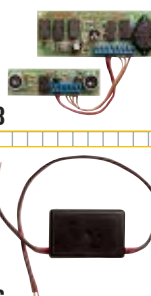

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CRUNCH! SOUNDS LIKE that Toyota in your rearview mirror really was closer than it appeared. Next time you back up, don't just rely on your mirrors; complement them with a homebuilt warning system made from a rearview video camera coupled with sensitive acoustic sonar. Safely tucked inside your car's taillight covers, the system pipes a video feed to an LCD monitor mounted on your visor and emits a warning sound when an object gets close to your bumper. And because it draws power from your car's reverse lights, it doesn't need batteries and activates only when you're backing up. So start driving like you have eyes in the back of your head—because now you will.—DAVE PROCHNOW

! H2WHO! Check local traffic laws to make sure it's legal to have a video screen in your visor and a camera and sensor mounted in your taillights.

 A	 B  C  D	PARTS (all available at jameco.com) A. Wireless color camera with video receiver (\$90) B. Velleman Parking "Radar" Kit (\$40) C. Three 78M12 voltage regulators (22 cents each) D. Battery-powered LCD monitor with video-input jack (free; salvaged) OTHER COMPONENTS 240-ohm resistor (\$1), .33μF electrolytic capacitor (95 cents), 5K trimmer potentiometer (\$1.35), 12-foot RCA video cable (\$5), project box (\$6.89), wire (\$6.59)
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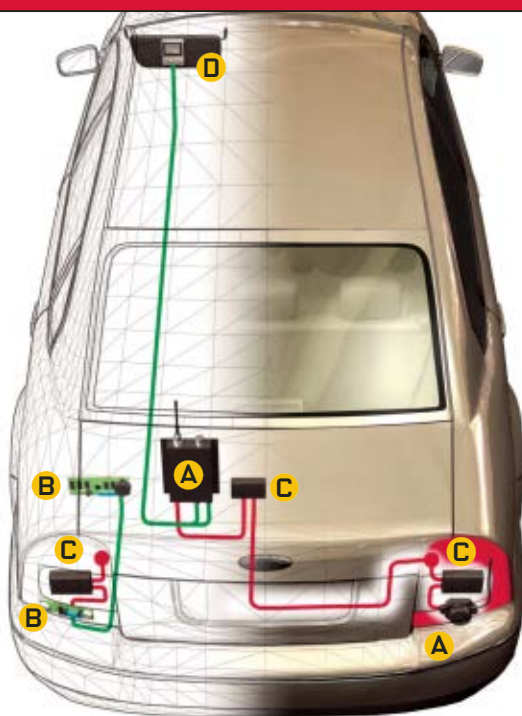
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EASY ||||| HARD

**1 BUILD THE REGULATORS**

Assemble three voltage regulators: one each for the camera, the video receiver and the sonar (the regulators include instructions).

2 INSTALL THE CAMERA

Remove a taillight cover—ideally, one that's not too opaque—and use clear sealant to attach the camera next to the reverse-light bulb.

3 POWER IT

Give the camera juice by connecting the positive lead from the camera's voltage regulator to the socket for the reverse light. Connect the ground wire (negative) to the car's chassis.

4 GET YOUR VIEW

Place the video receiver in the trunk and connect it to another voltage regulator (positive to socket, negative to chassis).

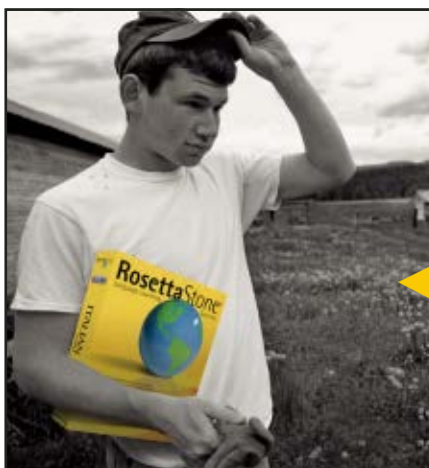
5 PLUG AND VIEW

Insert the video cable into the receiver's video-output jack. Route the cable through the inside of your car and plug it into the LCD monitor, mounted on the driver's side visor with Velcro fasteners.

6 ADD THE SONAR

Install the sensor inside either taillight and follow the kit's instructions for drilling holes in the taillight cover so that the acoustic sensors can detect obstacles behind you. Route the connection wires from the sensor through the taillight holder into the car's trunk or interior, and attach them to the main circuit board (this is the part that buzzes, so you want it somewhere you'll be able to hear it). Power the sensor from your reverse light with the last regulator (again, connecting positive to socket, negative to chassis).

STEVE CROSS



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FYI

S O M E T I M E S Y O U J U S T N E E D T O K N O W

Q Can I die from eating too many hot chili peppers?



A There is no known case of a person dying from eating too many peppers, although several masochists have certainly tested the limits. The reigning king of jalapeño consumption is Nevadan Richard LeFevre, who last October set the International Federation of Competitive Eating record by downing 247 pickled jalapeños in an eight-minute time limit.

Looking to top LeFevre and win a place in the *Guinness Book of World Records* is Anandita Dutta Tamuly, a woman from India who devoured 60 Bhut Jolokia peppers—the hottest pepper in the world—in just two minutes on national television. But she might not have anything on Mexico's Manuel Quiroz, who also wants a shot at the eating record and can squeeze habanero juice into his eyes without blinking.

Freakish tolerance levels aside, scientists have found that eating peppers can have medical benefits. Last March, researchers at Cedars-Sinai Medical Center in Los Angeles found that the chemical that makes peppers hot, capsaicin, can kill human prostate-cancer cells grown in mice. The scientists estimated that the dosage was equal to a 200-pound man eating three to eight habanero peppers three times a week.

But is there a deadly dose of spicy peppers? Researchers at Niigata University School of Medicine in Japan ran tests on mice to find out. After several hefty doses of pure capsaicin, most of the mice died of lung failure. Don't worry, though—you'd have to eat hundreds of thousands of jalapeños in one sitting to get the equivalent dose, and, the LeFevres of the world notwithstanding, most people beg for mercy after a dozen.

—BRANDON MILLER

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Q What's the worst sound in the world?

A The grinding whine of a dentist's drill? A beginning violin student? Not even close, according to researchers

ANTONELLO TURCHETTI/GETTY IMAGES; TOP INSET: ANDY REYNOLDS/GETTY IMAGES

in England who set out to determine the world's most repulsive sound.

The group, led by acoustic engineer Trevor Cox of the University of Salford, uploaded a selection of 34 sounds on sound101.org and asked users to rate each sound on a scale of one (not bad) to six (plug-your-ears-and-cry horrible). More than 1.6 million votes later, the answer was clear across all age groups and cultures: There's nothing worse than the sound of someone else vomiting.

To create what Cox calls the proper "slopping sound," the team had an actor make yacking noises while he dumped baked beans into a bucket. That vile audio snippet beat out strong contenders such as squealing microphone feedback and an electronic version of fingernails clawing a blackboard. "We're looking at what psychologists call a disgust reaction, which is a survival mechanism," Cox says. "If someone's coughing or vomiting, they're carrying disease, and thus we avoid it."

Although Cox believes that culture plays a role in what sounds we find repulsive, the instinct to be repulsed by the sounds of disease probably evolved as a mechanism to avoid catching an illness from a neighbor. In 2004, Val Curtis at the London School of Hygiene and Tropical Medicine ran a study using disgusting photos rather than sounds and also concluded that disease is universally the most revolting characteristic. For the record, the blue ribbon went to a photo of a person's gums infested with parasite eggs—which might even be gross enough to elicit genuine vomiting.

—FRED KOSCHMANN ■

BOOKS



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The typical ROM purchaser goes through several stages:

1. Total disbelief that the ROM can do all this in only 4 minutes.
2. Rhetorical (and sometimes hostile) questioning and ridicule.
3. Reading the ROM literature and reluctantly understanding it.
4. Taking a leap of faith and renting a ROM for 30 days.
5. Being highly impressed by the results and purchasing a ROM.
6. Becoming a ROM enthusiast and trying to persuade friends.
7. Being ignored and ridiculed by the friends who think you've lost your mind.
8. After a year of using the ROM your friends admiring your good shape.
9. You telling them (again) that you only exercise those 4 minutes per day.
10. Those friends reluctantly renting the ROM for a 30 day trial. Then the above cycle repeats from point 5 on down.

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(CONTINUED FROM PAGE 73)

CAN 6,831 LAPTOP BATTERIES CHANGE THE WORLD?

smoldering computer is a bummer; an electric car engulfed in flames is a catastrophe. Hence the lithium-ion piñata parties in Straubel's backyard (Tesla later turned to a failure-analysis lab for more rigorous testing).

Straubel then had to figure out the best way to physically assemble the batteries. The team started by supergluing cells together. Straubel vetoed this approach because it was deemed unsafe—and because he came home one evening to find a battery pack permanently affixed to his kitchen table. He eventually subdivided the battery pack into 11 sheets containing 621 cells apiece. In each sheet, the batteries slot into a structure that looks like a miniature wine rack.

He then spent the better part of a year trying to keep the rig from overheating. Originally he wanted to air-cool the battery pack. Air is free, after all. But lithium-ion batteries are extremely sensitive to heat. Consistent temperatures above 95 degrees inside the battery pack would shorten the lives of the batteries. Because the pack was so big and airflow so uneven, fatal hot spots kept popping up. The cooling team tried a bunch of potential solutions—ducts, blowers, manifolds, plenums. After months of work, they realized that sticking with air-cooling would mean cutting the size of the battery pack,

which would compromise the car's range. Instead Straubel opted to create a water-cooling system. This wasn't the work of a day; Tesla had to develop its own proprietary technology. But the battery pack is now fitted with a lattice of tubes that route cold water and antifreeze past each individual cell.

Fully charged and operating at peak efficiency, the battery pack gives the Roadster a range of 250 miles. Straubel predicts that it will retain 70 percent of its energy capacity after five years and 50,000 miles. Will this be good enough for the average buyer? It's certainly not a perfect solution, especially considering the not-insignificant cost of replacing the batteries—an estimated \$20,000.

Cost is a major reason that Chevrolet designed its own electric entry—the recently unveiled Volt concept car—with a hybrid powertrain that uses a small gasoline engine to help charge a lithium-ion battery pack. “You don't have to be a rocket scientist to understand that 6,831 batteries is a very expensive solution,” says Volt vehicle-line director Tony Posawatz. “That's fine for a \$100,000 vehicle, but we're looking at much higher volumes, so we're interested in larger cells with higher energy content.” Jim Hall, vice president of industry analysis at the research firm AutoPacific and a

veteran of the GM Impact prototype program, which was the EV's predecessor, is similarly dubious. “The battery pack is a classic example of an expedient stopgap,” he says. “It's not optimized for automotive use, and it's not designed for the environment it's going to operate in. It's one of those ideas that looks like a wonderfully simple solution to a complex problem—but isn't.”

Straubel has heard these criticisms before. “Some people say, ‘You're not using the perfect battery,’” he says patiently. “Fine. Where is the perfect battery? We're not against it. We're not shunning it. We just don't see it.” GM, for its part, openly admits that the battery technology needed to make the Volt a reality does not yet exist. The company hopes a third-party supplier will invent it. Straubel is not willing to wait.

THE SILENT KILLER

The satisfaction of driving the Tesla Roadster comes from acceleration: 0–60 in less than four seconds. That's racecar territory. When he's giving thrill rides, Eberhard likes to tell passengers to turn

(CONTINUED ON PAGE 107)



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“My Boyfriend’s **SECRET** ... for Amazing **INTIMACY!**”

I just had to tell your readers about a recent experience I had with my boyfriend. First, let me just say he is a great guy. But, after dating for six months, it seemed he was having confidence issues in AND out of bed. It was having a real negative effect on his sexual prowess and let's face it, with any new relationship, it's hard to connect intimately if you're lacking that sexual chemistry. My dilemma was that I really liked the guy.

Thankfully, I didn't have to make a difficult decision because everything changed a few days ago. I came home from work and he started touching and kissing me before I even made it through the door. Confident, aggressive, he made all the right moves. I definitely felt sensations I'd never felt before ... in places I forgot existed. We made love for what seemed like an eternity. I never knew what some of my friends meant when they said the earth moved from having sex – I do now. I can honestly say it was the most incredible experience I've ever had in my entire life.

When I asked him what was going on – what brought about the change – he wouldn't answer me. So I did what any red-blooded American woman would do, I started snooping. It didn't take me long to figure out his secret. In his underwear drawer under the “men's magazines”, was a tube of **Maxoderm CONNECTION**. After reading the fine print and finding the website, I went online to www.maxodermct.com to discover more about this magic in a tube.

Maxoderm CONNECTION (of which I'm having my boyfriend buy a lifetime supply) is a lotion that is applied topically to the most “intimate areas”. An all natural mix of herbs, it helps improve stimulation directly at the source – that's when amazing things start to happen. He's “stronger” and my pleasure soars to a whole new level of ecstasy! We aren't into taking pills of any kind – not even aspirin – so I was relieved to find he was using something topical without any systemic side effects. Unless you want to think of great sex as a side effect, because that's definitely what's going on at our place – ALL the time!

So ... please print this letter. Anyone who wants to experience mind-blowing intimacy has to try **Maxoderm CONNECTION**. They need to tell their boyfriends, husbands or partners about this product. Or just “accidentally” leave a tube lying around for them to “accidentally” find. I really want to thank the woman who developed **Maxoderm CONNECTION** – only a woman could design something that feels this good.

T.J.
Phoenix, AZ



“I felt sensations I'd never felt before ... in places I forgot existed.”



*P.S., Let your readers know I'm pretty sure they can still get a **FREE MONTH SUPPLY** of **Maxoderm CONNECTION** with their order by calling **1-800-797-5592** or by visiting their website at www.maxodermct.com, and **FOR A LIMITED TIME**, you can still get **\$200 worth of FREE GIFTS** with your order that are yours to keep – no questions asked. Oh and even better, their product is backed by a **90 Day Full Money Back Guarantee**.

From the Makers of
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(CONTINUED FROM PAGE 104)

CAN 6,831 LAPTOP BATTERIES CHANGE THE WORLD?

on the radio. As they lean forward, he nails the throttle, and the acceleration shoves them back in their seats before they can reach the dial. It's a geeky move, but it makes his point. With the electric motor limited to 13,500 rpm and 250 horsepower, the car tops out at a relatively modest 130 mph. But, as is typical with electric motors, it produces huge amounts of torque from the second you hit the gas all the way up through 8,000 rpm. This means the Roadster could get by with a single gear, although Tesla put in a *Pole Position*-like two-gear setup to give lead-foots a lower gear for giggle-inducing stoplight-to-stoplight performance. And because the configuration is based on the super-agile Lotus Elise, it handles as well as anything on the road, including the green 2000 Porsche 911 that Straubel usually drives. "The Porsche is frustrating as hell to drive compared with the Roadster," he says. "First of all, you have to shift gears. And it's an enormous amount of work to drive anywhere close to the limit. And sometimes I feel silly making all that freaking noise accelerating from a stoplight."

The first Roadsters are scheduled to start rolling down the Lotus Cars assembly line in Hethel, England, this summer. The entire first run—fewer than 100 cars—has been sold, and about 300 orders have been placed for next year, when 1,000 to 2,000 Roadsters will be built.

This, Straubel is convinced, simply marks the beginning. He predicts a million electric vehicles on the road in 10 years. Will they all be powered by thousands of laptop cells? Not a chance. Tesla needs a battery breakthrough to thrive. But 18650s are right here, right now, and Straubel has figured out how to get enough range out of them to make the Roadster into a viable proposition. It's the sexiness of this sports car that is its best chance of survival, though, and for all his hard work on the Roadster's guts, Straubel seems to recognize that. "When I'm driving the Roadster, I just love pulling up to the guys who have the hopped-up Civic Si's or whatever," he says. "I'm totally quiet.

But the next thing you know, I'm *gone* through the intersection, and all I can hear is this roaring exploding behind me."

Preston Lerner's last story for PopSci was about the Baja 1000.

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(CONTINUED FROM PAGE 88)

MEMPHIS, TENNESSEE, TO HOULKA, MISSISSIPPI

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"I tell you what, I'm not saying nothing about it, that's a nice-looking car. But I wouldn't want to have a wreck in that thing."—Billy Joe Logan, Houlika, Mississippi

South of Memphis, Highway 78 is nightmarish, a three-lane artery clogged almost exclusively with semi trucks. Stuck among them, Jenny and I must look comical—or suicidal. As we creep forward, a toothless woman in a yellow J.B. Hunt hat leans out the window of a neighboring semi and yells down at us, "Hey, is that a prototype?" The wind and rain pick up, and we keep weaving between the giants.

"At least you're sitting high enough that you don't feel like a victim," Dan Hall, of the consultancy AutoPacific, says of the Smart. This is the kind of damning praise experts heap on the car, which will have to fight the perception that its size makes it unsafe. On its side is that rollovers, which are involved in a third of U.S. traffic deaths, are a symptom of trucks and SUVs, not of cars. And in statistics for single-vehicle crashes, small cars fare far better than pickups. Half of all road fatalities are from multiple-car accidents, however, and in these the laws of physics are straightforward: It's the little guy who takes the hit. The multiple-vehicle fatality rate for subcompact drivers is 94 deaths per million drivers, twice the average. The fatality rate for SUV drivers is 21 per million.

The problem for the Smart is not the Smart itself, but that it's caught in the middle of America's SUV arms race, with everyone trying to be the safest on the road by being the biggest on the road—a sort of vehicular mutual assured destruction. If the country migrates to "crossover" SUVs on car platforms (and this is a growing trend), the Smart will become safer. Also, the IIHS's dire statistics—already skewed by the fact that young, fast, dangerous

drivers are more often in subcompacts than large SUVs—don't account for the fact that not all subcompacts are equal; the Smart is no Chevy Aveo or Hyundai Accent. In Europe's NCAP crash tests, the first-generation Smart got three out of five stars, better than the Ford Escort hatchback. The 2008 model will keep the "tridion safety cell," a roll cage of a cockpit that spreads impacts over

the whole of the car, and will have four airbags and standard electronic stability control, a skid-prevention mechanism that the IIHS says can reduce the risk of fatal single-vehicle crashes by 50 percent. As for the antilock brakes, I use them to great effect when a cop in Oxford, Mississippi, waves us down. Turns out he just wants to ask about the car.

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HOULKA, MISSISSIPPI, TO MONTGOMERY, ALABAMA

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"It's nice, but I dunno about fitting a beer cooler back there."

—Wayne Coleman, regular at the Washington Oil gas station in Houlika, Mississippi

Tucked in the back of the Smart, in the five-cubic-foot luggage compartment that will be expanded to eight feet in the next-generation model, Jenny and I have everything we need for a weeklong road trip: one small internal-frame backpack (mine), one carry-on-size duffel bag (Jenny's), a camera bag, two jackets, two laptops, a queen-size air mattress and two sleeping bags.

These last couple things are so that we can camp out for a night or two. One evening, not far from Montgomery, we find a nice spot in the parking lot of a Wal-Mart. For \$50, we buy a tent that's bigger than the Smart, set it up in the light rain and attempt to park inside of it. Our tent site is in a patch of pavement right next to an RV, but soon a manager comes out to tell us that tent camping isn't allowed for "liability reasons." Yes, even if you're inside your car inside your tent. We give up our plan.

The manager, a big guy in his 30s with a shaved head and an easy smile, is named Gray. Before working for Wal-Mart, he says, he and his wife ran a small retail store of their

own. He already had Wal-Mart stock, and after doing some research, he decided he wanted to work for the company. Now he manages 375 employees and a megastore where sales top \$200,000 a day. Fifteen miles down the road is another Wal-Mart Supercenter that does \$55 million a year, and 15 miles beyond that is one that does \$100 million. Of the \$70 million or so that Gray's store makes in annual revenues, the net profit is \$1.9 million—a margin of less than 3 percent.

Gray casts an approving glance at the Smart and tells us that he just replaced his Silverado pickup with a Scion. "I was spending \$60 on gas every three days," he says. "Now I'm spending \$20 every six days." Here in the land of Wal-Marts, people appreciate efficiency.

MONTGOMERY TO DOTHAN, ALABAMA

3.12 gallons, \$7.75, 38 miles per gallon

"You should put a great big handle on the top. Then if you break down, you can just pick it up and carry it with you."

—Donnie Mock, regular at the BBQ House in Troy, Alabama

We've picked the final stop of our road trip, Dothan, almost solely because of its Continental Drive-In theater, which operates four screens year-round below the starry Alabama sky. We're almost there when we spot a bar and restaurant

(CONTINUED ON PAGE 112)

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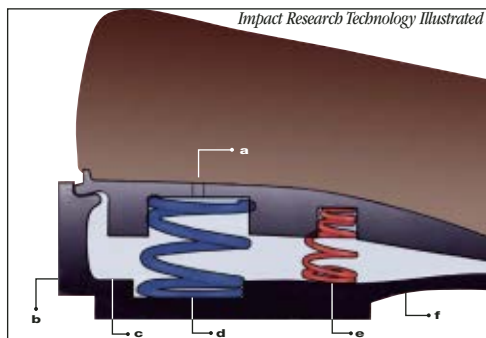
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(CONTINUED FROM PAGE 110)

called the BBQ House on a lonely stretch of Highway 231 and decide to stop in for some ribs. Parked outside are full-size trucks—an F-350, a Silverado—and parked inside are full-size people. Paul weighs 350 pounds, Donnie weighs 330, Chester is 6' 3" and stands rather than sits due to a "broke knee."

At first their comments are polite but unenthusiastic, even a little snide—"Not much room for luggage," "I wouldn't want to get in a wreck in it," "Truckers must want to squash you like a bug"—but one of the regulars, Ron, seems to take the Smart seriously. "Well, I'll be damned," he says. "I need one of those just to get back and forth from my house." He makes his living delivering oversize signs around the country, and for that there's only one tool: his '07 Dodge Ram with the 6.7-liter Cummins turbodiesel. For his nightly 30-mile commute between his home and the BBQ House, he falls back on his hunting vehicle, a gas-guzzling Ford 4x4. The Smart is looking mighty appealing.

After Paul asks if he can put his Chihuahua, Chico, in the Smart, Chester decides to sit down in our "little buggy." He emerges impressed. "I tell you what," he says, "if I can get in there with my knee, anybody can get in there." He tells us that the last time he went to the drive-in was with a girl named Jackie Eddins in 1962, just before he joined the Air Force. "These cars will sell," he says. "We need these. We need a whole bunch of these." It's this reaction that must be

Smart's dearest hope—that people will look at it not as a fashion statement, but as a simple solution to a problem.

At the drive-in, images of Jude Law and Cameron Diaz fill the windshield, and our rapture is interrupted only by the periodic automatic shutdown of the radio. The car is smart enough to let you turn on the radio without a key in the ignition but not smart enough to know that you might want to listen to a whole movie.

I'm checking us out of Dothan's Best Western the next morning when a maid named Freda taps me on the shoulder. "Is that your car?" she asks. "Lord, that's the ugliest little car I have ever seen in my entire life. Nobody in their right mind would buy a little car like that." It's a rental, I say. She asks why I'm in Dothan, and I explain that Jenny and I wanted to go to the drive-in. Freda laments that most of the other drive-ins have closed. "It's probably because of all the baby-making that went on there." I assure her that's not a problem in the Smart. "It's still weird-looking," she says. "It looks like it's been chopped off at both ends." A maintenance man has been listening in from across the lobby, and finally he interjects: "I'll bet it gets real good gas mileage, though." I tell him I've been getting 40 miles a gallon, and Freda pauses long enough to take another look at the Smart.

"What other colors does it come in?" she asks.

McKenzie Funk's last feature story for POPULAR

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*Dr. Guy Abraham M.D. (UCLA) and others.



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warned about cigarettes and pure water products. Although we sell thousands of machines, those that don't listen may become victims of their own folly! Since we are engineers, not doctors, visit our website (www.johnellis.com) and read the signed letters. You will know why government officials, including Senators, are regular visitors to our 418 acre estate and Research Center celebrating this patented discovery! It may save your life!

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“The Amazing Exercise Program That Transforms Couch Potatoes into Super-Hero Fitness Machines”

It doesn't matter how OLD you are. It doesn't matter how out of shape you are. *Combat Conditioning* will turn your life around.

By Matt Furey

Best-selling author of *Combat Conditioning*

I was the total skeptic. Not only had I lifted weights and run long distance for years, but I had major success under my belt, including a world kung fu championship and a national collegiate wrestling title.

So I just didn't want to believe what Karl, a 76-year old man told me about exercising **WITHOUT** weights... and **WITHOUT** long-distance running.

Most importantly, I didn't want to hear that a good exercise program only took a few minutes. Hate to admit it, but I was addicted to the “hard work or nothing” mentality and refused to believe you could get into the best shape of your life by doing **LESS**... not more.

Let me tell you, when I looked at this so-called “old man's” physique and watched him demonstrate his exercises, I could not look the other way. I had to check them out for myself, even if it meant saying, “Okay, I've wasted a lot of time doing it the wrong way.”

What I discovered shocked me from head to toe!

Before I met Karl I **THOUGHT** I was strong. I thought I was tough. But the exercises he gave me exploited every weakness that weights and running could not cover. In a matter of minutes, I knew Karl “had me.”

So I gave up the weights and began a routine of bodyweight calisthenics called **Combat Conditioning**. After all, when a man of 76 can do things that a 36-year old cannot do, that tells you that “Yes, there's gold in them there hills.”

The exercises I learned had such a profound and dramatic effect on me, that for six years I have been introducing men and women of all ages and of all backgrounds to this extraordinary program – and the results are shocking, awe-inspiring and **PROOF** that this system works, and works **FAST**.

Who is Combat Conditioning for?

It's for the hard-working man or woman who often finds it difficult to squeeze in a quick workout.

It's for the traveling executive who sleeps in hotel rooms more than at home.

It's for those who have trained their whole lives on weights.

It's for athletes, martial artists and the military.

And .. **IT'S FOR** the man or woman who hasn't done a lick of exercise in decades.

Even One Minute a Day Brings Results!

Unlike other exercise program where you are told you **MUST** do 30 minutes of cardio per day and an hour of weights, to get results, **Combat Conditioning** is totally different. 15 minutes is all it takes to whoop the hard-core trainee. But for the total beginner, he or she can get results starting with **ONLY** one minute a day. And no, this is not a joke.

Time is not the issue!

Forget all those workouts that take all day. With **Combat Conditioning**, all that's required is your own

body and a tiny “get started **NOW**” decision to **DO** a little something each day.

The key to your success is in the magical, transformative power of these exercises – not in your belief system about hard work. For many people, just one rep is all they can do at first, and they're shaking like a leaf on a windy day in Chicago. And so, that's all that person should do at first. Even if you think you're not doing enough – the exercises work their magic anyway. Your body has it's own intelligence and will work **FOR YOU** if you'll simply get out of the way and let it.

When you do, pretty soon you'll be the type of person who can do 2, 4, 8, 16, 32, 64 or 128 repetitions and feel no fatigue. Instead of tiredness you'll feel exhilaration and **ENERGY**. You're building strength and endurance from the **INSIDE-OUT**. And believe me, once you can do more than a few reps, inches of unsightly fat and pounds of excess flab will fly off your body at break-neck speed.

New Results from Forgotten Exercises

Are the exercises in **Combat Conditioning** **NEW**? Well, not really. They go back about 5,000 years – but for the most part, they got lost in the shuffle when weights, gadgets and gyms came around. So although they aren't **NEW**, they're “New to **YOU**!”

Before I learned these exercises, I read about the Great Gama of India, a wrestler who followed this program and was unbeaten in 5,000 matches. I also read that the legendary Bruce Lee did these exercises, too. And we all know about Lee's incredible martial arts skills. Then there was the All-Pro NFL running back, Hershell Walker, who did bodyweight exercises each day. The list goes on and on. The key is in having a proven program with a track record, and **Combat Conditioning** is just that.

Puts you into the Old Clothes You Dream of Wearing Again!

The main reason why **Combat Conditioning** works is because it targets all the weak links in your body. And when all those weak links are given a little attention, your entire body gets stronger, faster, more powerful and more energetic. Spend time each day doing a few functional exercises and the payoff is **HUGE**.

You get functional strength, endurance and flexibility – all at the same time. Not to mention seeing the excess inches flying off your body, making it easy for you to fit into the clothes you dream of wearing again. Stop dreaming. Start **DOING**. And get results.

12 Ways Combat Conditioning Will Change Your Life!

Follow this program and your body is going to change big time. In fact, I've made a list of 12 of the most powerful benefits that hundreds of thousands of others all over the world have gotten from the **Combat Conditioning** program. Let's take a look:

1. **Cranks up your metabolism so you**

burn excess body fat a lot, lot faster. This means fitting into the clothes you WANT to wear.

2. Packs attractive and healthy functional muscles (not grotesque) onto your entire body
3. **Simultaneously doubles your strength and flexibility – and does so without needing separate workouts for each.**
4. Quadruples your endurance inside of 30 days. Never get tired again.
5. **Within a couple weeks, it often eliminates chronic back and shoulder pain from years of heavy squats, deadlifts and bench pressing – or other forms of abuse.**
6. Sleep like a log. Eight hours of deep sleep is no longer a goal. It's automatic. As soon as you hit the rack you're out like a light.
7. **Your self-confidence will have no bounds. Especially when you get compliments from people who hardly paid attention to you before.**
8. You can train anywhere. You don't need more than a few square feet of carpet or pavement and you're all set. You don't need equipment. Just your own bodyweight.
9. **You get a kick-butt workout done in 15 minutes or less.**
10. You'll turn back the clock. Friends may tell you that you look 5–10 years younger.
11. **You'll have an explosive type of strength that weights cannot give you. Your every movement will be lively and full of vigor.**
12. Your muscles will be pliable and powerful, like a tiger's.

Here's How to Order

Combat Conditioning: Functional Exercises for Fitness has 48 super effective bodyweight exercises along with seven different programs that will get you into kick-butt shape fast. Order **NOW** and you'll receive 3 free Special Reports on how to eliminate knee, back and shoulder pain. Your total investment in this no-nonsense book is only \$29.95 plus \$6 S&H U.S. (foreign orders add \$12). Order online at www.mattfurey.com.

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Matt Furey

won a national collegiate wrestling title in 1985 and a world shuai-chiao kung fu championship in 1997. Furey has a knack for taking the average and ordinary person and transforming him with his powerful programs. Furey was inducted into the Edinboro University Athletic Hall of Fame in 1998 and spends much time each year traveling throughout the world, searching for the very best information available to his world-wide audience. His website, www.mattfurey.com, is one of the finest in the world, giving valuable information that changes lives.



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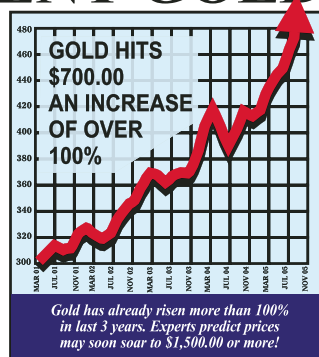
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Important breakthrough in male sexuality

Science Uncovers the Mystery of the Ultimate "O"

How a bodybuilder's problem led to the biology behind the world's most intense natural high

of seminal fluid released during ejaculation caused men to have multiple vibrant climaxes and thrilling orgasms that reached a higher dimension. Users express the reawakened pleasure and youthful sexual appetite that resulted in a newfound confidence in the bedroom; one that their partners could immediately notice and appreciate.

Paravol's results are due to its patented approach. Its unique ingredients target the sources of male sexuality. First, Paravol stimulates testosterone production within the body, while also balancing the body's estrogen level—the key to enjoying testosterone's positives attributes without the negative side effects. Next, Paravol stimulates seminal fluid production. The increased ejaculate volume is what enables men to experience more powerful and a greater number of contractions; more contractions mean longer, more intense orgasms. This also allows for multiple performances, since there is a greater supply of semen. Paravol also increases nitric oxide levels, which results in greater blood flow to the genitals, hence firmer, longer-lasting erections. The beneficial science of the nitric oxide is based on Nobel Prize winning studies that shows that nitric oxide helps stimulate circulation and blood flow at the body's periphery—just where you need it.

Why Choose Paravol Over the Competition?

Quite frankly, Paravol doesn't have any competition. That's because no other product on the market is designed to increase the intensity and duration of the male orgasm. Wouldn't you love to experience the world's most intense natural high? Be sure that you are strong enough and healthy enough to reach this kind of euphoria. And guess what—she will love that too.

Please consult with your physician before taking any nutritional supplements. If you are on any medications, check with your doctor regarding dosage adjustments. These statements have not been evaluated by the FDA. This product is not meant to diagnose or treat any disease.

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Is there a way to scientifically enhance your ability to reach a stronger, more lasting, ultimate natural high? Why does the intensity and duration of this spectacular pleasure diminish as you get older? A stunning breakthrough in biological research begins in the secretive world of hardcore bodybuilding. Originally developed to combat the severe negative effects of anabolics by bodybuilders, Paravol (Ophenafil HCL) is the non prescription formula that heightens the intensity and prolongs your sexual ecstasy. The scientific studies started with treating the extremely low levels of testosterone that are often the problem of bodybuilders—testosterone is the key biological trigger that creates sexual intensity in men. Instead of simply adding testosterone to the body, Paravol stimulates the body's natural production of testosterone and seminal fluid. *Double blind clinical results on the key ingredient, fenugreek, show a 98.8% increase in serum testosterone levels after 8 weeks.* The results of this research dramatically improve euphoria, intensity and actual duration of the male orgasm. Effects were especially dramatic for men over the age of 40 when natural levels of testosterone drop. Not only did users experience a rejuvenated sex drive, but due to Paravol's unique formulation, they also enjoyed increased stamina, erectile strength, and most unique, orgasms that were dramatically longer and more intense than ones they had experienced before.

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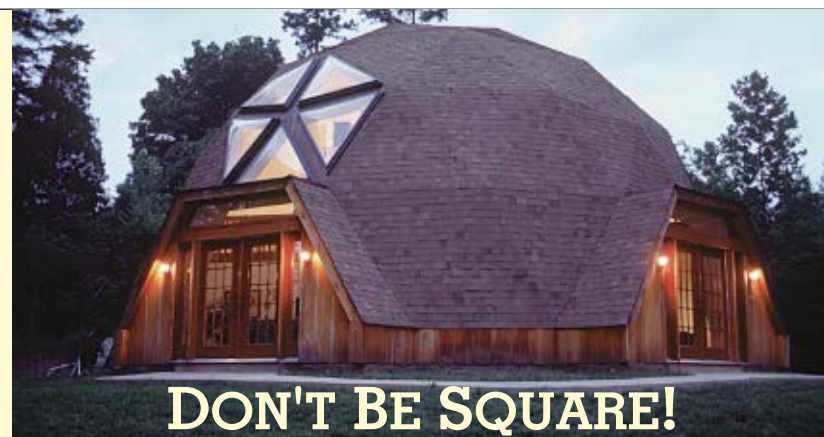
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Like a picked flower cut from the source, we gradually wilt physically and mentally and become vulnerable to a host of degenerative diseases, that we simply weren't susceptible to in our early adult years.

Modern medical science now regards aging as a disease that is treatable and preventable and that "aging", the disease, is actually a compilation of various diseases and pathologies, from everything, like a rise in blood glucose and pressure to diabetes, skin wrinkling and so on. All of these aging symptoms can be stopped and rolled back by maintaining Growth Hormone levels in the blood at the same levels HGH existed in the blood when we were 25 years old.

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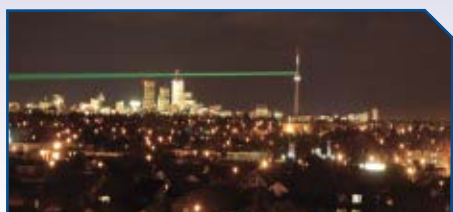
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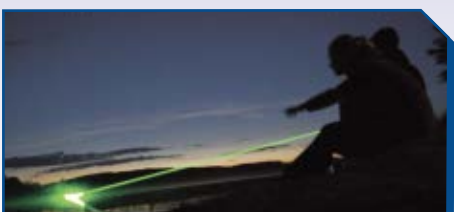
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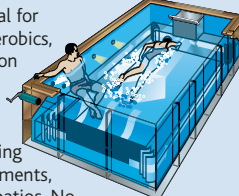
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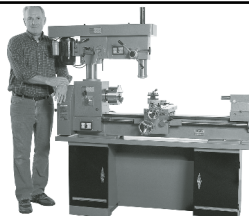


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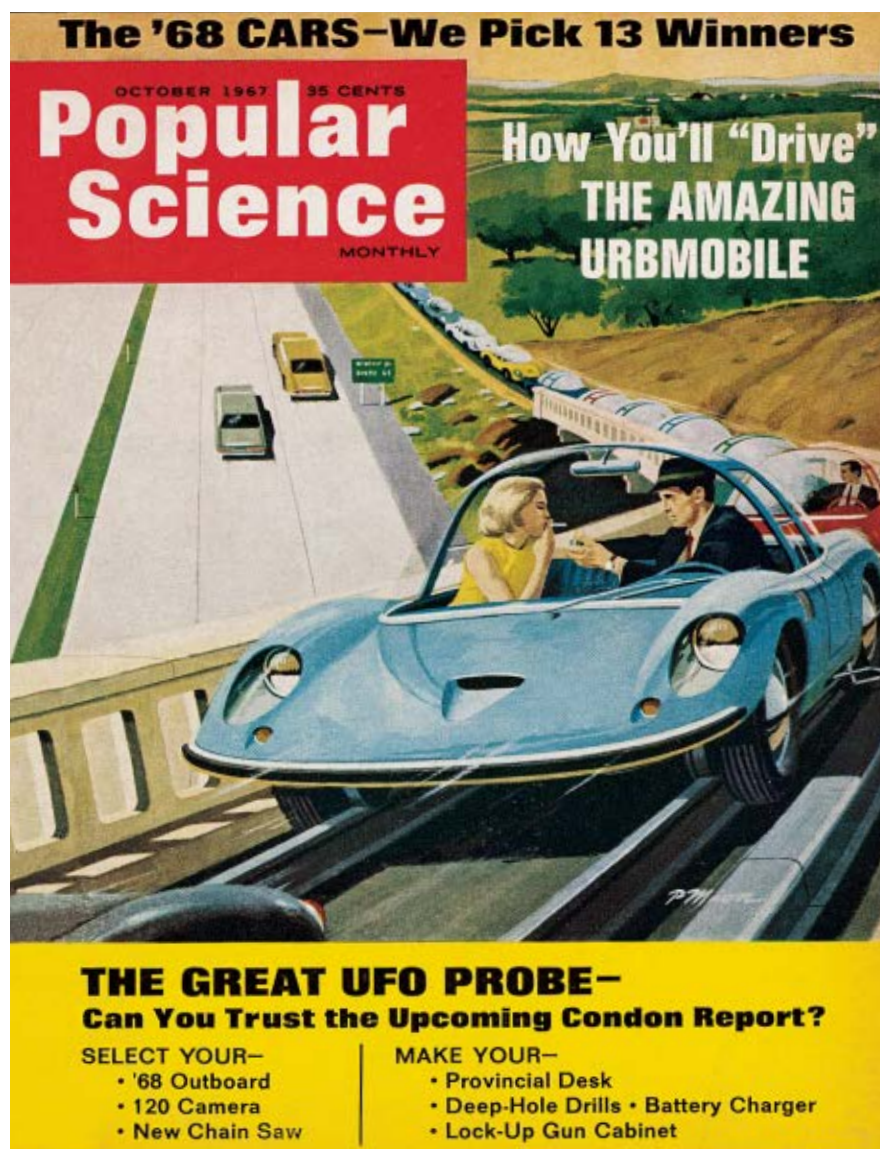
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THE MILITARY'S X-FILES

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